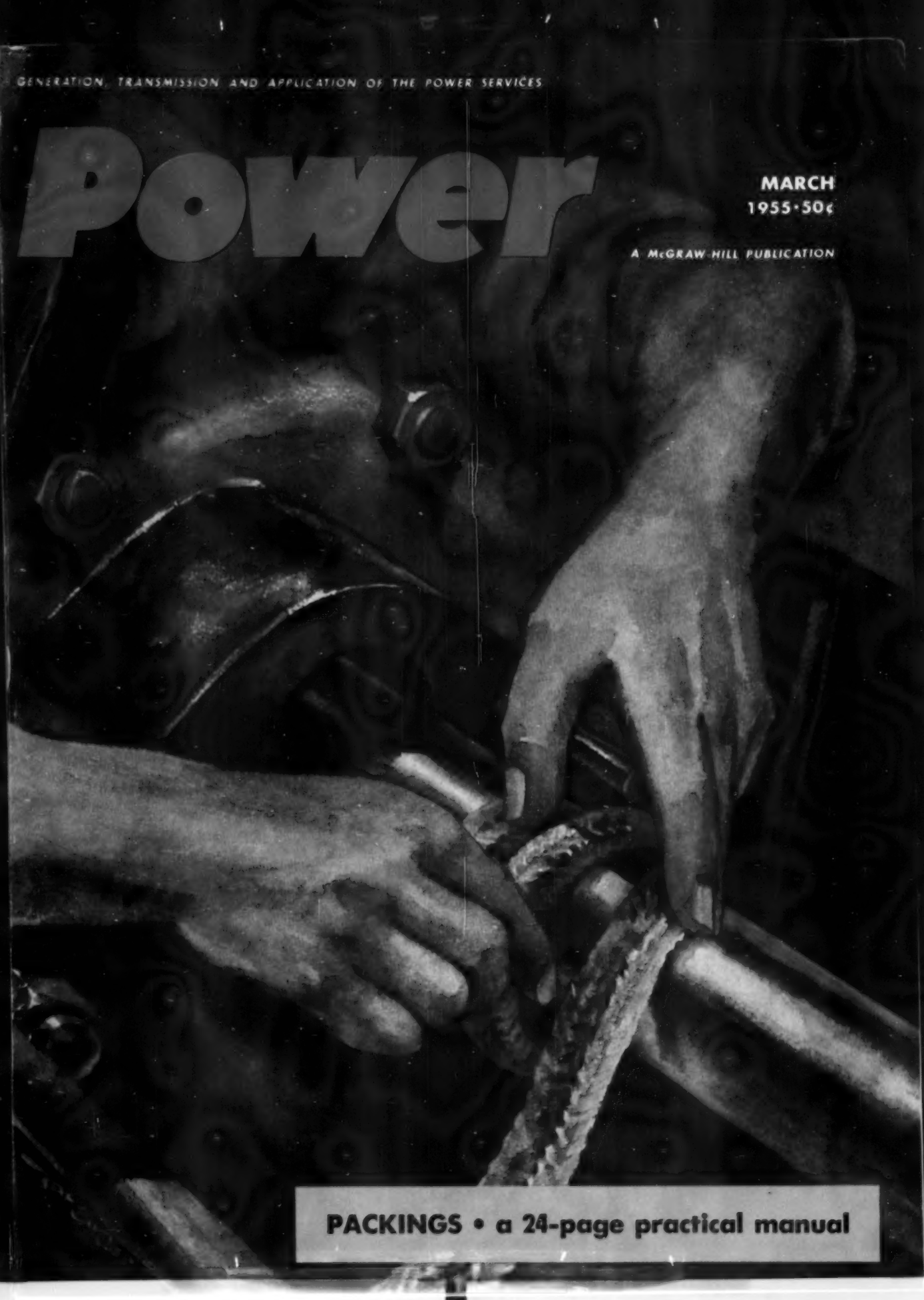
GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

Power

MARCH
1955·50¢

A McGRAW-HILL PUBLICATION



PACKINGS • a 24-page practical manual

For outdoor plants...

Metermax control features all-weather electric drive units

Forced draft fan vanes are controlled by outdoor-mounted Metermax drive unit shown above.

In winter snow or summer heat, weather never bothers the electric drive units which do the muscle work for Metermax Combustion Control. Ideal for modern outdoor station design, these units are specifically designed to operate without added protection from the elements. If a forced draft fan is mounted outdoors, for example, its damper control drive mechanism goes outdoors too—without any steam jacketing or weather shelter. Because driving power is electrical, there's no danger of stoppages due to freezing or clogging.

Here are other drive unit features of interest to power engineers:

Self-Locking: double worm and gear drive can't be backdriven; no locking devices needed.

Self-Releasing: no unlocking or resetting by operator.

Simple Remote Control: instantaneous transfer from automatic to remote manual control; no reset position because system is electric.

Emergency Operation: geared-down handwheels on each unit make it easy to move heavy dampers, etc.

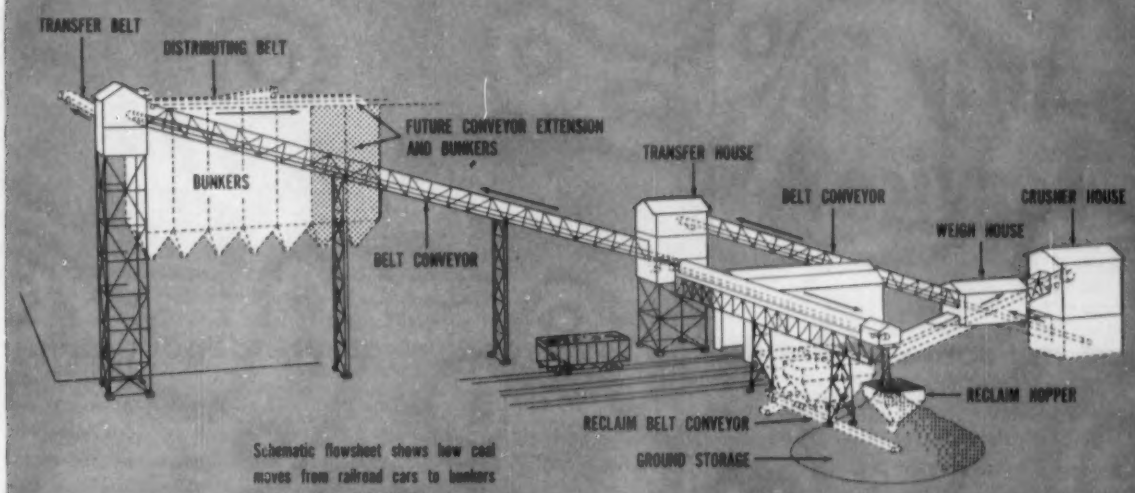
True Position Indication: Electric indicators are unaffected by friction or sticking of dampers.

Dependable Power Source: drive units operate from plant auxiliary power, independent of compressed air supply.

For a copy of our new folder giving full details on Metermax drive units, write to Leeds & Northrup Company, 4910 Stenton Avenue, Philadelphia 44, Pa.

LEEDS NORTHRUP

One of nation's most efficient stations moves coal on LINK-BELT conveyors



Schematic flowsheet shows how coal moves from railroad cars to bunkers at West Springfield Station of Western Massachusetts Electric Co.

Simple, flexible system designed for future expansion

THIS New England station's heat rate places it within the top group of the most economical in the U. S. Typical of this high efficiency is the Link-Belt coal handling system that is designed to carry twice the present 250 tph without a change in equipment. And, just as Link-Belt engineers worked hand-in-hand with Stone & Webster and the power company's staff, so they can help you get the finest in modern coal handling. Get in touch with your nearest Link-Belt office for a copy of Book 2410 that shows the latest layouts and equipment for power plants, large and small.

LINK-BELT

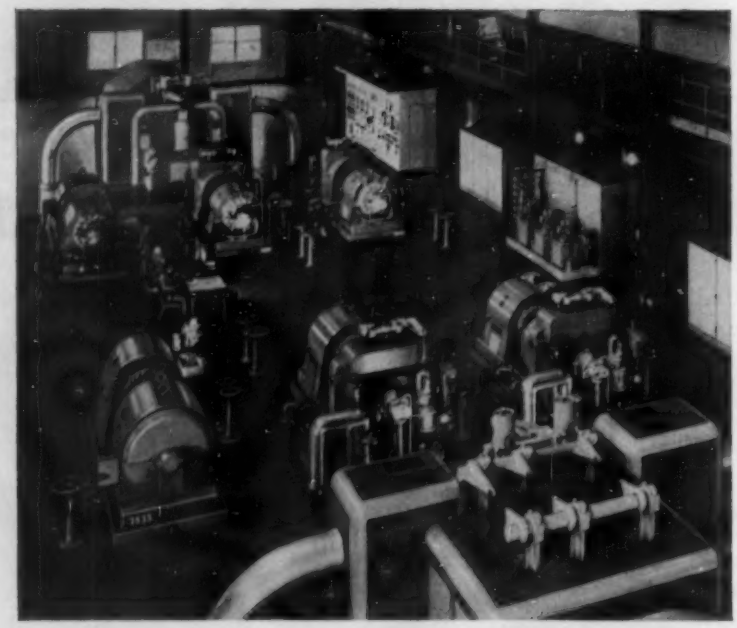
COAL HANDLING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,595

Belt conveyor in foreground feeds crushers. Crushed coal goes to bunkers or to reserve storage on conveyor in background.

Stocking-out conveyor is one of seven Link-Belt belt conveyors. Coal is weighed on its way to bunkers and in and out of storage.

What makes a barrel-type boiler feed pump *stay in service?*



Here are some of the design features that assure dependability

Today's modern multi-stage centrifugal pumps for boiler feed service are the result of years of research and design. To provide efficient service *plus* dependability, De Laval has incorporated these important features in its barrel-type pump.

Double Volute Diaphragms

Double volute diaphragms provide for radial hydraulic balance and assure a continuous rising head characteristic from the design point to shut-off. *RESULT—Higher efficiencies are maintained over a wider range of operation than are generally obtained with other forms of velocity pressure conversion.*

Individual Diaphragm Bolting

Elimination of rabbet fits and gaskets permits straight metal-to-metal contact of adjacent lapped faces of the diaphragms which are individually bolted together to maintain tight joints and ease of assembly. *RESULT—Positive assurance against inner case leakage, complete elimination of misalignment causes and a minimum of distortion from sudden temperature changes.*

Positive Sealing Between Suction and Discharge Chamber

Inner assembly is held at the inner high pressure joint at the suction end of the barrel, against a flexitallic gasket, with through bolts. The joint between the suction and discharge chambers is made tight during assembly—remains tight whether pump is operating or idle. *RESULT—No possibility of leakage or gasket loosening due to changes of force on the inner joint.*

Bare Shaft

Bare shaft construction with split ring-shrink fit method of impeller mounting permits a scalloped shaft design and eliminates the need for spacer sleeves between impellers. *RESULT—Better hydraulic conditions at the eye of the impeller and elimination of spacer sleeves—the greatest cause of shaft warpage.*

Wearing Rings

Diaphragms and impellers have renewable wearing rings. Impeller rings are threaded on the impeller hubs against rotation, and diaphragm rings are held by a breech lock fit in the diaphragms. *RESULT—Construction permits renewal of original clearances without major part renewal or modification. Labyrinth type diaphragm ring results in minimum leakage over a longer period of time than with close clearance flat rings.*

IMO Oil Pump

A De Laval IMO pump designed for high speed operation is direct-connected to the outboard end of the barrel pump shaft, and is sized to lubricate both pump and driver bearings. *RESULT—Quiet, pulsation-free, positive displacement IMO pumps, assures positive lubrication and eliminates the need of extra shaft length and mechanical complications required by gear drive lube oil pumps.*

BULLETIN CONTAINS HELPFUL DATA

This De Laval bulletin on the barrel-type boiler feed pump covers all major design points . . . has cross-section cut-away illustration for easy reference. Write on your business letterhead for your copy of Bulletin 1506 to De Laval Steam Turbine Company, 815 Nottingham Way, Trenton 2, New Jersey.

Power

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POWER articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index.

PACKING CLOSE-UP on this month's cover shows the old standby—braided flax packing being measured for jam-type packing box. This type of packing and box are probably the most familiar to POWER readers because they are so widely used for water service. As Steve Elonka points out in his "Practical Manual" beginning on p 107, the packing should be wrapped around the rod or a mandrel before it is cut. This insures correct joints.

The water color, painted by Kent Day Coes, of the McGraw-Hill Illustration Dept, is based on suggestions by POWER's Art Editor, Charlie Marschalek, and Steve. Coes blended the many ideas into a unified whole, coming up with "roughs" that received searching study from all members of the staff. The finished painting tells its own important story about the Manual.

Next month...

■ Welding fittings and flanges, important in a wide variety of piping systems are the subject of April's lead article —a 5-pager. This interesting picture story shows how welding fittings are being used today to cut costs.

■ Insulating an outdoor boiler for a central station poses plenty of problems, especially when you realize that winds in the area of this plant sometimes hit over 80 mph. See the April issue for practical ideas on modern insulation.

■ Turbine pumps, long a favorite for many industrial pumping applications, are the subject of a new series of articles. Follow this series for real know-how on this important type of pump.

■ Another modernization story—Motor Products Corp, Detroit, Mich., where the investment for new equipment will pay out in less than five years. Ingenious salvage of existing equipment reduced costs in this installation.

...and future months

■ Refrigeration, the daily concern of a large section of POWER's readers, will be the subject of a POWER handbook later this year. Plans call for a concise discussion of principles, components, application, installation, operation.

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...lines and bylines

Editor flies high to get latest info on packing

Elonka and Lee Layton, pilot for Van der Horst Corp

PACKING may be just packing, but to Associate Editor Steve Elonka it adds up to thousands of miles of travel, talks with a large number of manufacturers, plant operators and engineers in related fields.

While in Palmyra, N. Y., getting packing know-how from Garlock Packing Co, Steve called Van der Horst Corp of America in Olean, N. Y., about data on hard-chroming of rods and shafts to reduce wear from packing. They offered their plane to fly him to Olean.

But it wasn't all high-flying fun. Back at his desk, Steve beat the keys for two months. Art Editor Charlie Marschalek prepared the layouts with an eye to readability and neat appearance. Al Thornton, Assistant Editor, chased down copy and drawings.

Steve says the seas were rough during the whole trip, but we hear that packing manufacturers and plants all over the country gave him a welcome blast when he hove to. For the results of this work, turn to p 107, where you'll find the latest on all types of packings.

STEAM PLANTS, their design, construction and economics have been Pete Sichel's interest and work for the last 14 years. Starting with the American Gas & Electric Service Corp in 1941, Pete has been with a number of other consultants, and at present is a mechanical engineer with Gibbs & Hill. His article on condenser selection, p 91, is based on long experience with this knotty problem.

Peter Sichel

Starting at Stevens Institute, Sichel completed his engineering education at Cooper Union School of Engineering, graduating with a BME. He did some graduate work at Polytechnic Institute of Brooklyn and is a licensed PE in New York State. Active in ASME, Pete was Chairman of the Power Division in 1953-54. He has taught instrumentation at Pratt Institute. For relaxation, Pete enjoys his family, skiing, gardening and music.

...with Power readers...

DATA SHEET . . .

In reviewing the January Data Sheet I note that the two plants listed for North Dakota have a higher unit cost per kw than the 175 plants listed in other states. The unit cost of $309 per kw given for North Dakota plants does not represent a fair unit price for plants constructed in this state during the last five years.

The Minnkota Power Cooperative, Grand Forks, N. D., was constructed for $4.4 million, and includes three units having a capability of about 24,500 kw. Unit cost of this plant is about $180 per kw with coal-fired boilers. Steam plants constructed in North Dakota should have about the same unit cost as those in Minnesota. Unit cost for seven Minnesota plants is $184.

L J NEUBAUER
Ellerbe and Co, St. Paul, Minn.

PULSATING COMBUSTION. . . .

Our POWER articles (Aug and Nov '54) are setting off a small boiler-house revolution in Europe. Almost all big German boiler firms are tinkering with pots and tubes. . . . I've seen a few and they run well. . . . One oscillates in resonance—but without high heat transfer at the bottom of the pot.

F H REYNST — *Paris, France*

2 B&W Boilers Make Major Contribution to efficiency and

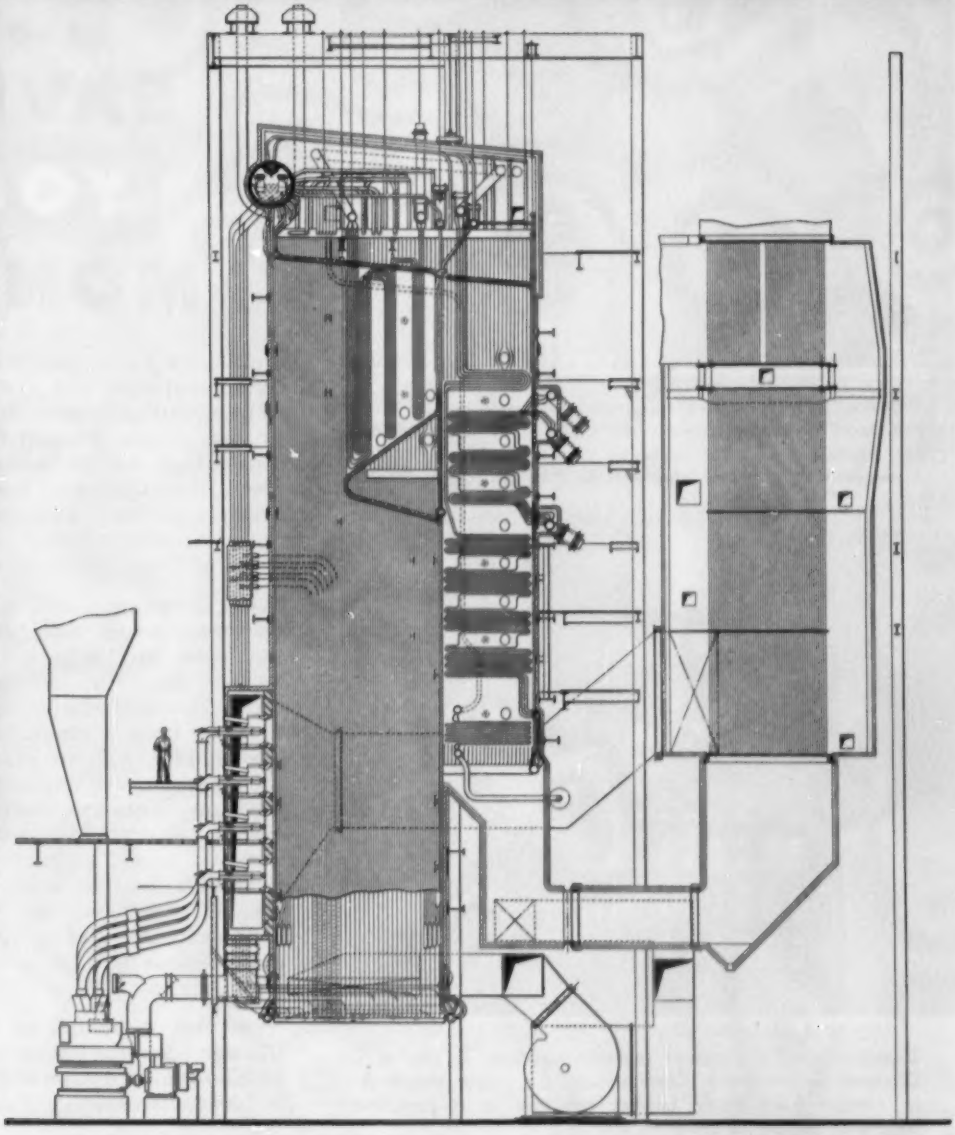
Utilizing design improvements developed to increase power generation efficiency and raise the level of unit availability, Pennsylvania Electric Company's new Shawville Station truly typifies power progress while demonstrating Penelec's awareness of future requirements in the area it serves. Currently operating as a two-unit plant, Shawville Station will eventually be expanded to 4 units and have a capacity totalling more than 500,000 kw.

Another addition in General Public Utilities' expansion program, Shawville Station is situated in coal fields near the center of Penelec's system load. Its two identical B&W Radiant Reheat Boilers have a design pressure of 2080 psi and a combined steam capacity of 1,788,000 lb per hr. These units include B&W Cyclone Steam Separators for natural circulation and each is equipped with 16 burners served by 4 B&W Pulverizers. This installation also includes B&W tubular airheaters and B&W continuous-tube type economizers.

Modern in every sense, Shawville Station has already demonstrated its efficiency during the first months of operation. It is one more practical tribute to the unending efforts of progressive electric companies, consulting engineers and B&W boiler experts working cooperatively to further advance the science of steam-electric power generation.

high availability
at SHAWVILLE STATION

Shawville Station of the Pennsylvania Electric Company. Engineering design and construction supervisory services by Gilbert Associates, Inc.



One of two identical, dry-bottom B&W Radiant Boilers now supplying steam at Shawville. Steam capacity is 894,000 lb per hr per unit. Steam pressure is 1900 psi at the superheater outlet and temperature is 1055 F with reheat to 1005 F.

BABCOCK & WILCOX
BOILER DIVISION

G-687

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BOILER CLEANING AND SAVES YOU MONEY

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Diamond Service Engineer instructs operator in use of the Diamond Selectromatic Control Panel . . . how simple it is to change from single blower selection to a completely automatic sequential program.

The severe punishment that boiler cleaning equipment must take in the normal course of its operation emphasizes the importance of the unique Diamond Service Policy. Throughout the 36 years it has been in force, this Diamond Service Policy has made significant savings and important improvements in boiler cleaning for many users of Diamond Blowers.

Every installation of Diamond Blowers in stationary water tube boilers is regularly inspected and adjusted *(unsolicited and without charge)* by one of the many full-time Diamond Field Service Engineers working from strategic points throughout the country. On an inspection call, the Diamond Service Engineer sees to it that the blowers are in good repair and adjustment . . . instructs operators in their correct use and care . . . recommends blowing schedules for maximum economy. Often he will detect potential trouble before it becomes serious or costly. This preventive maintenance has been of great value to many operators.

Numerous users tell us that this unique Diamond Service Policy was as important as the superior design of Diamond Blowers in their decision to buy Diamond equipment.

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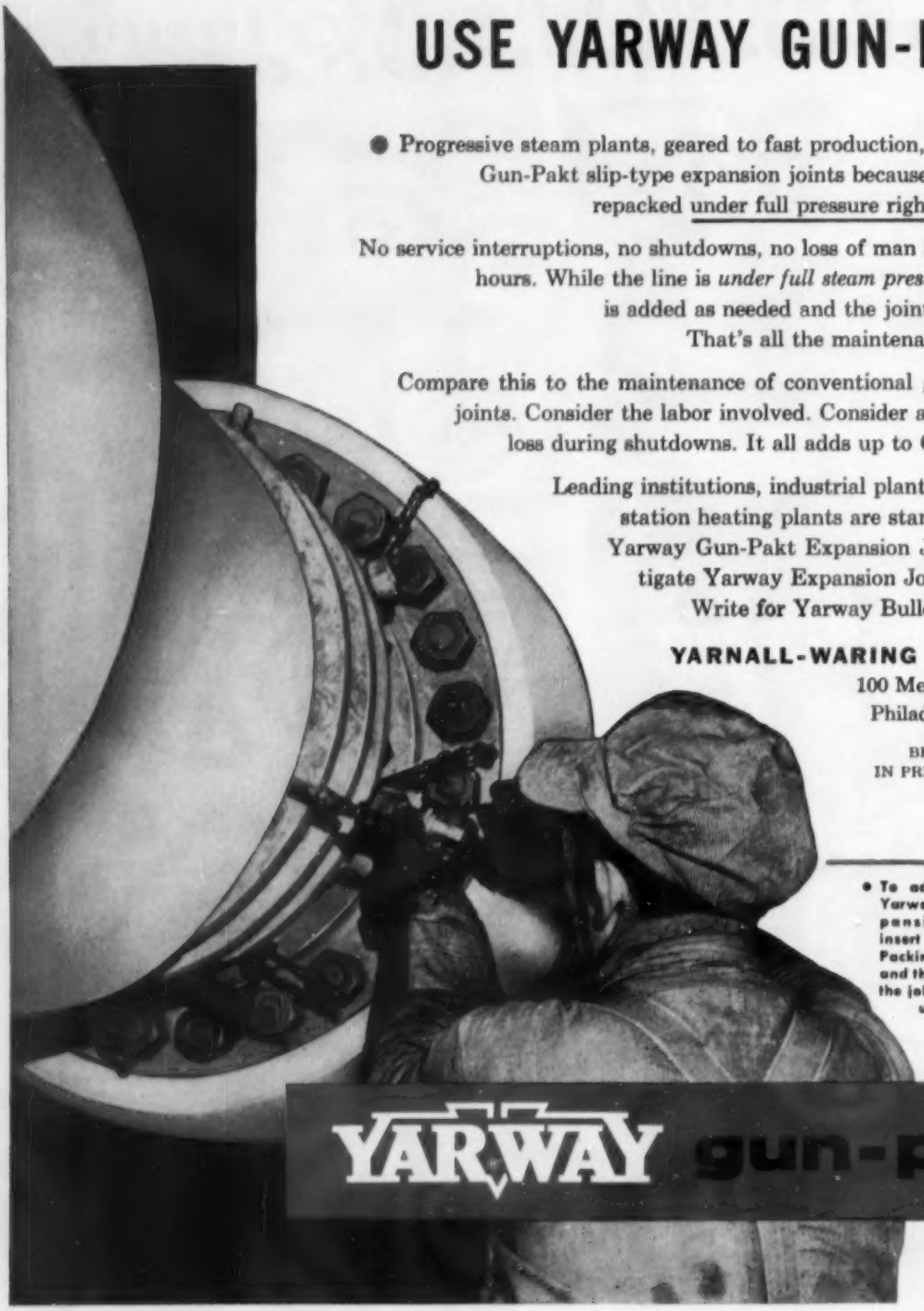
DIAMOND SERVICE IS EFFECTIVE PREVENTIVE MAINTENANCE

going places?

DON'T BOTHER TO UNPACK..
USE YARWAY GUN-PAKT



● Progressive steam plants, geared to fast production, use Yarway Gun-Pakt slip-type expansion joints because they can be repacked under full pressure right on the job.

No service interruptions, no shutdowns, no loss of man and machine hours. While the line is *under full steam pressure*, packing is added as needed and the joints lubricated. That's all the maintenance required.

Compare this to the maintenance of conventional gland-packed joints. Consider the labor involved. Consider also the profit loss during shutdowns. It all adds up to GUN-PAKT.

Leading institutions, industrial plants and central station heating plants are standardizing on Yarway Gun-Pakt Expansion Joints. Investigate Yarway Expansion Joints yourself. Write for Yarway Bulletin EJ-1913.

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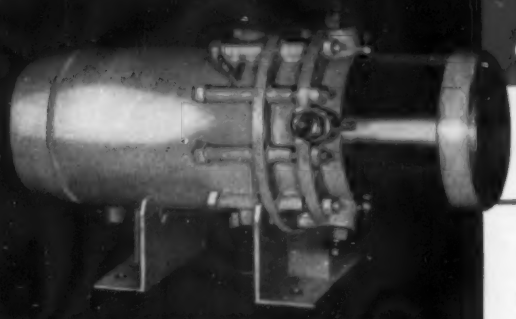
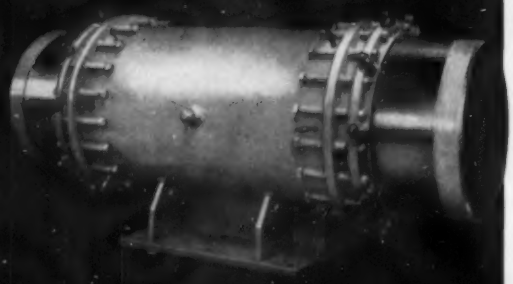
● To add packing to a Yarway Gun-Pakt Expansion Joint, just insert Yarway Plastic Packing, twist a wrench and the joint is tight . . . the job done. *There is no unpacking operation.*

YARWAY gun-pakt

EXPANSION JOINTS



Single end, welding-type Yarway Gun-Pakt Expansion Joint with base for pressures to 300 psi. 12 inch traverse.



Double end, welding type Yarway Gun-Pakt Expansion Joint with base for pressures to 300 psi. 24 inch traverse.

compare these maintenance records

	YARWAY GUN-PAKT JOINTS	CONVENTIONAL GLAND-PACKED JOINTS
STATE UNIVERSITY*	Required addition of only 3 slugs (45 cents) of packing in 5 years. Lubrication only once every 6 months. Total labor time of only 2 manhours in 5 years.	Same lubrication as Gun-Pakt, *plus* gland tightening, *plus* complete overhaul with shutdown for unpacking and repacking every 3 to 4 years. Time for overhaul—25 manhours per joint!
MID-WEST AIRFIELD*	Only maintenance was lubrication and addition of 2 slugs (30 cents) of packing per year. Total labor ¼ manhour per joint per year.	Lubrication and gland tightening required 8 manhours per joint per year—plus complete unpacking and overhaul every 2 to 3 years. Time required for overhaul—20 manhours per joint.
"BIG TEN" UNIVERSITY*	Lubrication only once every 2 months, with packing added as needed. Total labor time charged, 1 manhour per joint per year.	General maintenance requires 6 manhours per joint per year. Complete overhaul required every 2 to 3 years with unpacking and repacking—24 manhours per joint.

*Names on request

expansion joints

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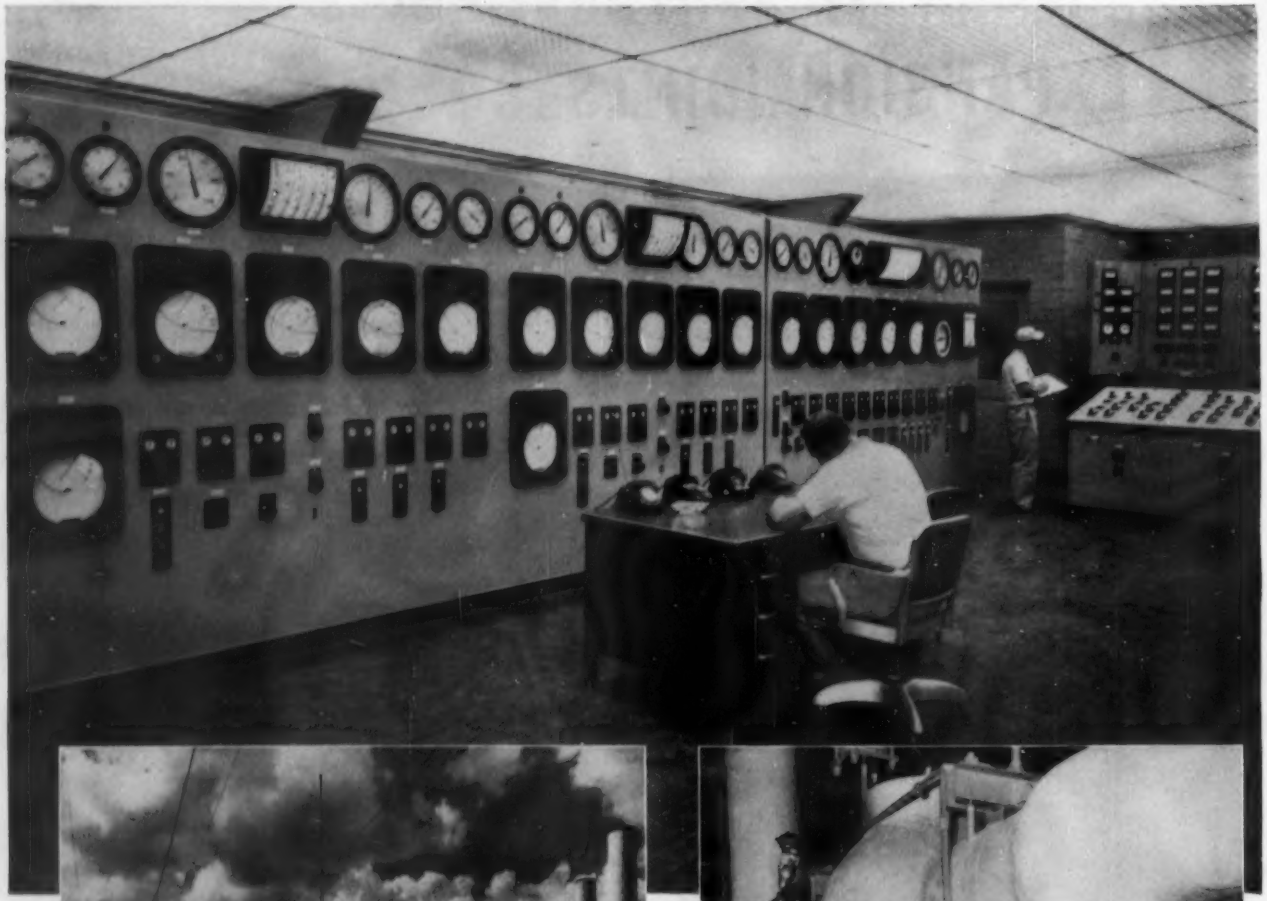
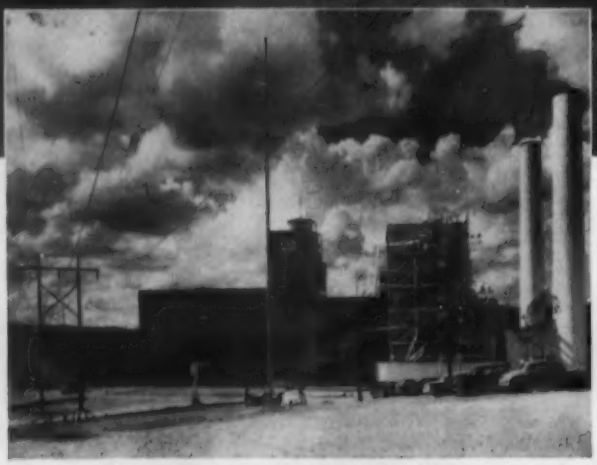
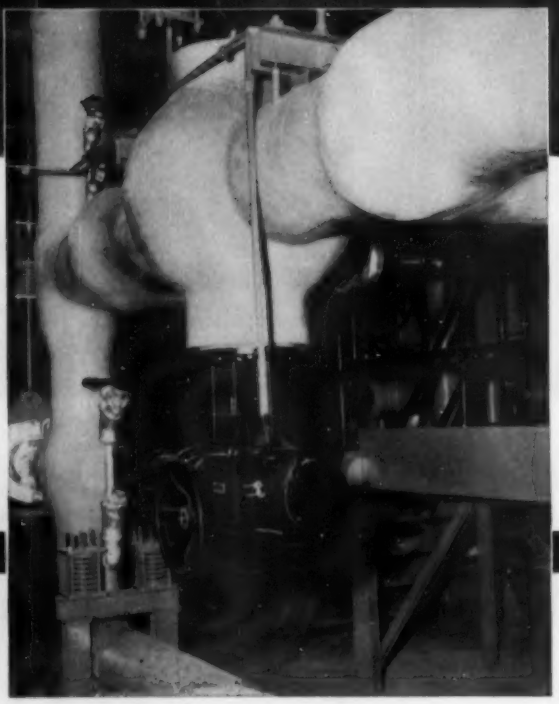
BLOW-OFF VALVES
WATER COLUMNS AND GAGES
LIQUID LEVEL INDICATORS
IMPULSE STEAM TRAPS
FINE SCREEN STRAINERS
SPRAY NOZZLES
DIGESTER VALVES
HYDRAULIC VALVES

Here's the *1,153rd*







**At Lake Catherine Station,
Arkansas Power and Light Company**

***Above*—Centralized control room for Bailey Controls of Feed Water, Combustion and Steam Temperature.**

***Right*—Bailey Three-element Feed Water Control Valve.**

Installation of . . .

Bailey Three-element Feed Water Control

★ This installation of three-element feed water control at the Lake Catherine Station of Arkansas Power and Light Company is not the latest, the largest, or the most unusual; but it is important to you as a user of power generating equipment.

Here's why: It is a part of the widespread and well founded acceptance of Bailey Three-element Feed Water Control Systems. No other manufacturer can offer you an equal background of experience in this advanced method of feed water control.

Contributing to this overwhelming endorsement are several factors: Not only has the basic principle been proved and re-proved in use, but the design of the equipment has been similarly stabilized and improved. As a result, Bailey has established a reputation for successful operation in difficult installations where other systems have failed. And a twenty-five year backlog of experience has contributed unusual records for accuracy and dependability in operation.

Even more important, the Bailey field engineering service, established in important industrial centers, insures prompt and efficient service and installation supervision regardless of your location. Your local Bailey office will be glad to arrange an inspection trip to a near-by installation of Bailey Three-element Feed Water Control. Give them a call today. And for catalog literature, including a partial list of installations, write for Bulletin No. 105-C.

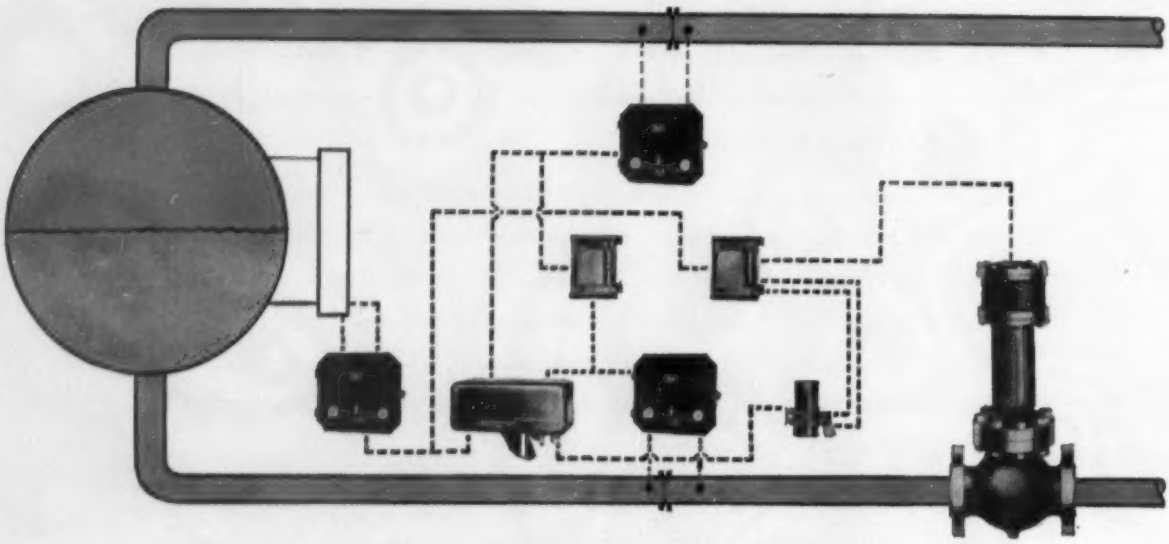
A-122-2

BAILEY
METER COMPANY
1036 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Steam Plants

BAILEY METERS
Controls for
COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED FLOWS

NEW! COPES offers a choice of

. . . **WITH** **RECORDING INSTRUMENTS**



From the oldest comes the newest in three-influence feed water control—Copes Type 3-L with Taylor instruments. A minimum of instruments are required due to simplicity. Miniature recorders are indicated above. Standard size recorders may also be used to supply as many as four records on one chart. Each component of the Type 3-L system is selected for its accuracy and high quality. Each installation is backed by nationwide service, whenever or wherever required, for its entire life.

Copes three-influence control may also be actuated mechanically or electrically

COPES

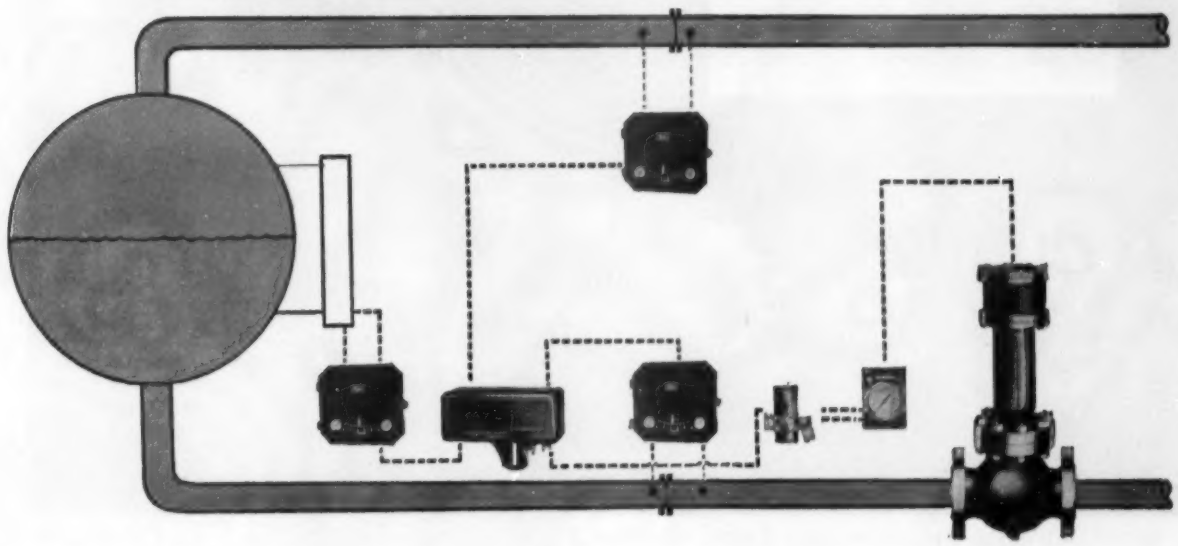
First to develop continuous

BOILER FEED

TYPE 3-L SYSTEM

3-influence controls

. . . **WITHOUT** **RECORDING INSTRUMENTS**



To further simplify a 3-L system, recorders may be omitted. The schematic shown above is the simplest instrument-type Copes three-influence feed water control system that is available. Ask for Bulletin 103-A which describes the combinations available in Type 3-L feed regulation.

COPES-VULCAN DIVISION

CONTINENTAL FOUNDRY & MACHINE COMPANY

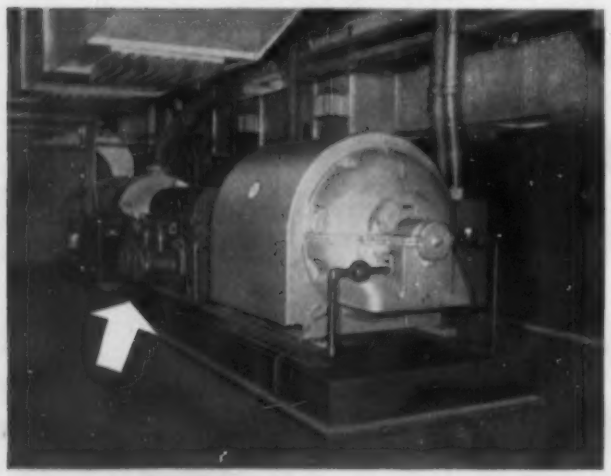
ERIE 4, PENNSYLVANIA

boiler feeding under automatic control

WATER REGULATION

New England Electric System

Narragansett Electric Company's South Street Steam Station in Providence, R.I. Company is a leading subsidiary of New England Electric System, one of 12 largest electric utility systems in the United States. A multi-million-dollar expansion and modernization program was recently completed at South Street.

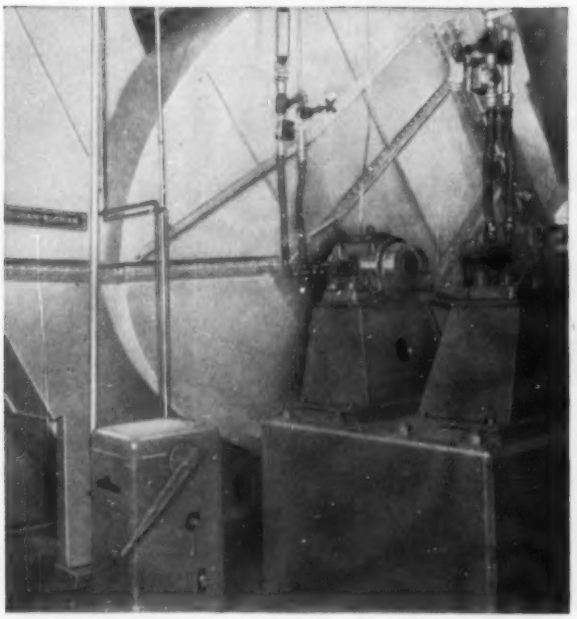


For boiler-feed-pump control, American Blower Type VS, Class 6 Gyrol Fluid Drives are installed at Narragansett's South Street Station. Rating is 2500 hp at 3600 rpm.

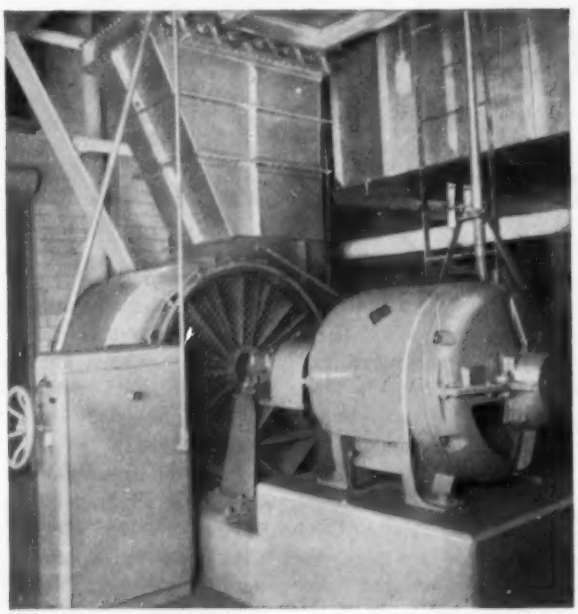
South Street Station is heated by American Blower Type H Steam coils. Capacity: 75,000 cfm at 70°F. Coils are made from tubes of 90-10 cupra nickel.

Serving home and industry: **AMERICAN-STANDARD** •

boosts capacity to 1,000,000 kw



Narragansett uses American Blower Sirocco Induced Draft Fans for air handling. Capacity: 130,000 cfm of gas at 300°F at 22″ sp at 875 rpm.



American Blower Sirocco Forced Draft Fan at Narragansett's South Street Station has radial inlet vane control. Capacity: 75,000 cfm of air at 80°F at 18″ sp at 875 rpm.

Narragansett Electric Company, a leading subsidiary of the New England Electric System, relies on American Blower products in its expansion program.

In less than fifty years, the New England Electric System has grown from a one-plant operation to the largest utility electric system in New England. A total of 37 plants (including 24 hydro, 12 steam and 1 Diesel operated) supply power to nearly 250 communities in five states. The system now has a rated generating capacity of 1,000,000 kw.

NARRAGANSETT EXPANDS

As part of New England Electric's vast program of expansion and modernization, The Narragansett Electric Company, Providence, R.I., a leading subsidiary, recently completed installation of a new Boiler Topping Unit in its South Street Station, increasing its capacity to 207,000 kilowatts. Steam is taken from the new boilers at 2000 pounds per square inch pressure and 1000°F, and delivered to the Topper. To ensure smooth, adjustable-speed control of the boiler feed pumps, Narragansett chose American Blower Gyrol Fluid Drives—Type VS, Class 6. Narragansett also uses American Blower Forced and Induced Draft Fans, Steam Air Heaters and Ventilating Fans.

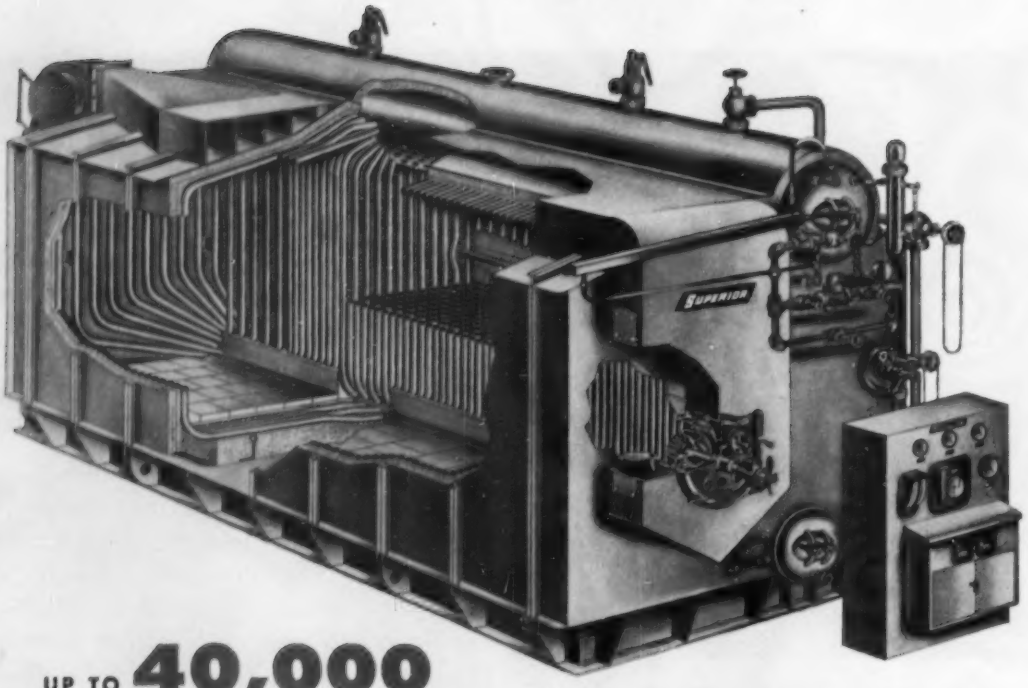
CALL ON AMERICAN BLOWER

If you are planning to expand or modernize your facilities, contact your nearest American Blower representative. He can recommend efficient, economical equipment – including Mechanical Draft Fans, Fly Ash Precipitators, Dust Collectors, Heavy Duty Steam Coils and Gyrol Fluid Drives for boiler feed pump and fan control. Call your nearest American Blower Branch Office for full information.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS



UP TO 40,000
POUNDS OF STEAM PER HOUR

Up to 40,000 pounds of steam per hour plus overload. Where rail clearances permit, still greater capacities. Designed to comply with or exceed Government Specification MIL-B-17095B. Either left or right hand units can be supplied.

NEVER BEFORE... *So Much*

Whether you are building, modernizing, or expanding, ***so many*** features contributing to low cost steam demand your consideration.

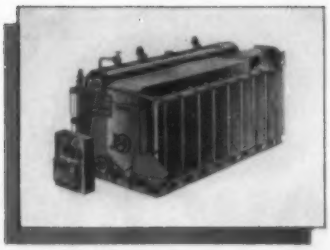
Completely integrated units combining the basic Type D boiler tube arrangement with the most modern features of boiler design, Superior Type D Water Tube Steam Generators are engineered for efficient firing with oil, gas or both. Performance rated for high availability and long life, with continuous steaming capacities of 40,000 lbs. per hour plus overloads, they may be economically combined in batteries for total plant capacities of 160,000 lbs. per hour. Each Superior Type D Steam Generator is completely assembled and fire tested at the factory. They may be transported by truck, rail or boat.

There's no guesswork about Superior Steam Generators. They are designed, engineered, built and tested by Superior Combustion Industries, Inc. whose boiler division specializes in the exclusive manufacture of packaged steam generators.

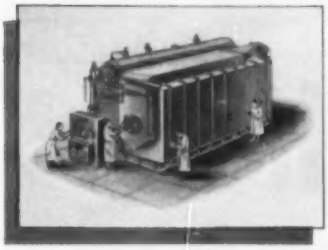
For complete details and dimensions, write today for your copy of Catalog 700-W

SUPERIOR COMBUSTION

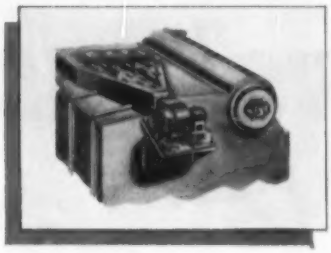
TIMES TOWER, TIMES SQUARE,



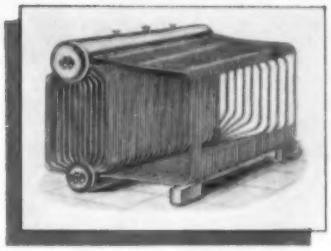
Rotary cup or steam assisted burners. Multiple burners where required on larger units. Burners for oil, gas or both in combination available on all size units.



Completely plant assembled and factory fire tested under actual conditions for which purchased, to prove performance and efficient operation before shipment.

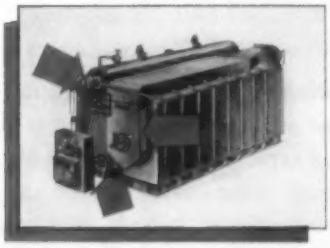


Rear mounted forced draft fan keeps firing front clear and provides proper distribution of air to burner register preventing distortion of flame characteristics.



Large waterwall furnace. Tangent tubes all riser elements, discharge directly to steam drum. Drums extend both ends for maximum volume and releasing area.

in a packaged boiler



Adequate inspection openings. Refractory lined access door. Two manhole openings in each drum on sizes over 15,000 lbs. per hr. optional on smaller sizes.

for performance you can ***BANK*** *on*

INDUSTRIES, INC.

NEW YORK CITY 36, N. Y.

SUPERIOR STEAM GENERATORS

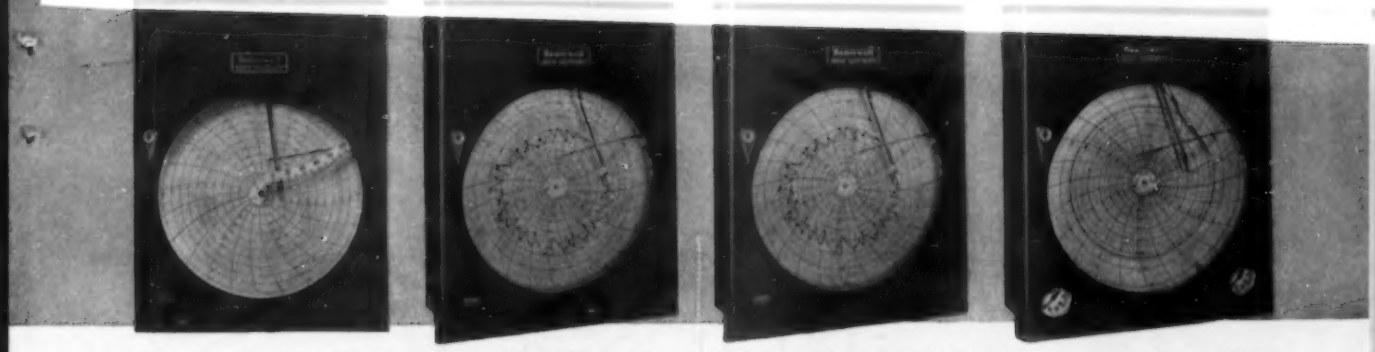
Only Brown flow meters offer you these profitable "*plus*" *values*

- ***16 different types*** of basic instrument systems . . . a flow meter for every fluid, every pressure, every operating requirement. *You're sure to find the most profitable meter for your specific application.*

- ***Nearby service facilities.*** There's a Honeywell service center as near to you as your phone. Service by factory-trained specialists is prompt, competent and economical. *You're sure to get maintenance and start-up service without delay.*

- ***27 years of experience*** in flow metering development and application work. *You're sure to get specialized engineering on your flow metering problem.*

- ***Nationwide field organization.*** Brown flow metering consultation is available from experts in more than 90 field offices, located near every major production center. *You're sure to have application engineering on hand where and when you need it.*

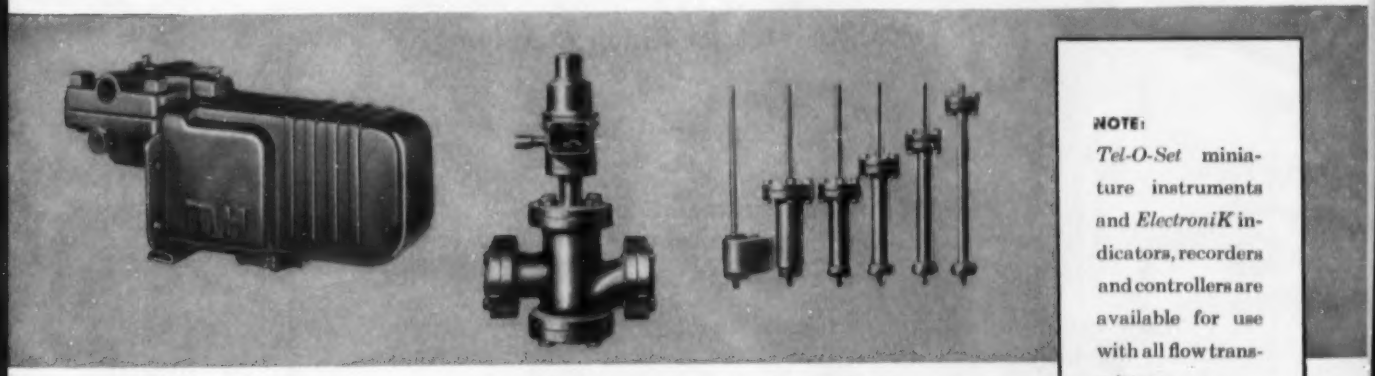


Linear scale meters—mechanical or electrical types, all control forms.

Square root scale meters—mechanical, or electrical or pneumatic transmission . . . all control forms.

Portable meters—versatility, for spot checks of flow values not continuously recorded.

Low pressure meters—either electrical or mechanical type, for air or gas flow.



Differential Converter—mercury-less pneumatic flow transmitter with infinitely adjustable range.

Area Type Meters for measuring flow of viscous fluids . . . electrical transmission.

Interchangeable range tubes typify rangeability of all Brown flow meters.

NOTE:
Tel-O-Set miniature instruments and *ElectroniK* indicators, recorders and controllers are available for use with all flow transmitters.

a flow meter for every fluid...

every application (all available with electronic integration)

In performance, too, Brown flow meters provide you unsurpassed precision . . . reliability . . . convenience . . . with minimum maintenance requirements. In every way, you'll find it pays to select your flow meters from the one line that offers the most value.

Your nearby Honeywell sales engineer will be glad to discuss your specific flow application . . . and he's as near as your phone.

Minneapolis-Honeywell Regulator Co., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

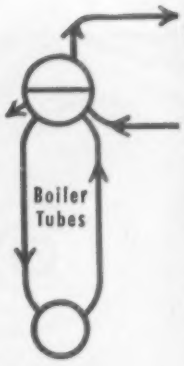
● **REFERENCE DATA:** Write for new Catalog 2320, "Flow Meters, Indicating, Recording, Integrating, Controlling."

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

dual circulation

provide high-purity steam

- with high feedwater makeup
- with high silica content feedwater
- at pressures above 600 psi



Cost-saving advantages of the exclusive FW dual circulation system now thoroughly proved by over 6 years of successful operation

THE DUAL CIRCULATION STEAM GENERATOR was developed by Foster Wheeler to provide a practical means of reducing carryover of silica and dissolved solids from 100% makeup feedwater. At pressures over 600 psi, this carryover often causes costly turbine outages. With today's trend to higher pressures and temperatures, and larger sized units, carryover problems are sharply accentuated and the dual circulation principle offers still greater advantages.

As shown in the diagram above, the Dual Circulation Steam Generator utilizes two separate heat-absorbing sections, each with its own independent natural circulating system. The primary section, comprising principally the furnace walls, is blown down at a high rate, providing the feed to the secondary section. Steam from the secondary system is returned to the primary, where it is condensed in whole or in part by the incoming feedwater. Hence, virtually all of the steam delivered to the turbine is generated in the low-concentration primary section, thus sharply reducing silica carryover and total dissolved solids.

Predicted data on the first FW Dual Circulation Steam Generators have been fully confirmed by more than six years of operation with five 300,000 lb/hr, 1350 psi units having 100% makeup. Average silica carryover is only .004 ppm, compared to .08 ppm expected for a boiler of conventional circulation. Carryover of total dissolved solids is .007 ppm, compared to .56 ppm expected for a conventional unit.

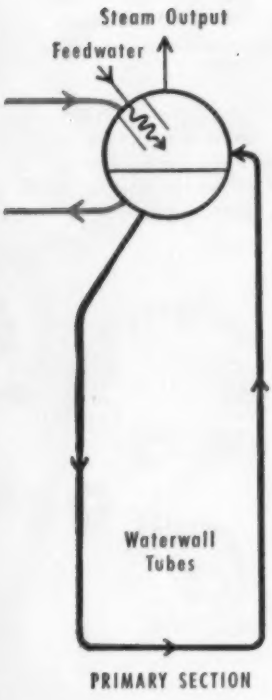
Additional benefits include reduction of tube damage due to low concentration in primary section; reduced final blowdown with substantial saving in blowdown heat recovery equipment; and reduced cost of the makeup treating plant.

Wherever *high purity steam* is required, in central station or industrial service, FW Dual Circulation Steam Generators offer important savings in operating and maintenance cost.

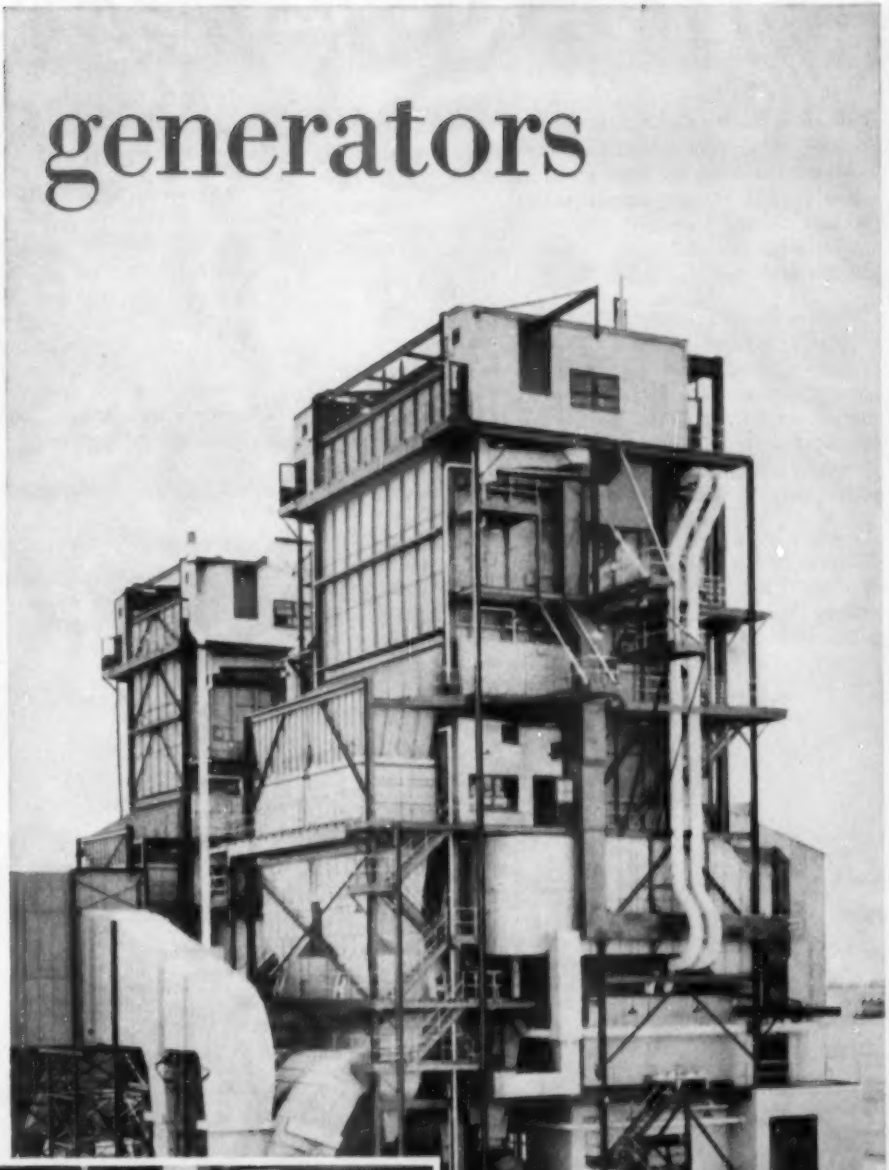
FOR COMPLETE INFORMATION on FW Dual Circulation Steam Generators, send for your free copy of 16-page Bulletin B-50-11. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

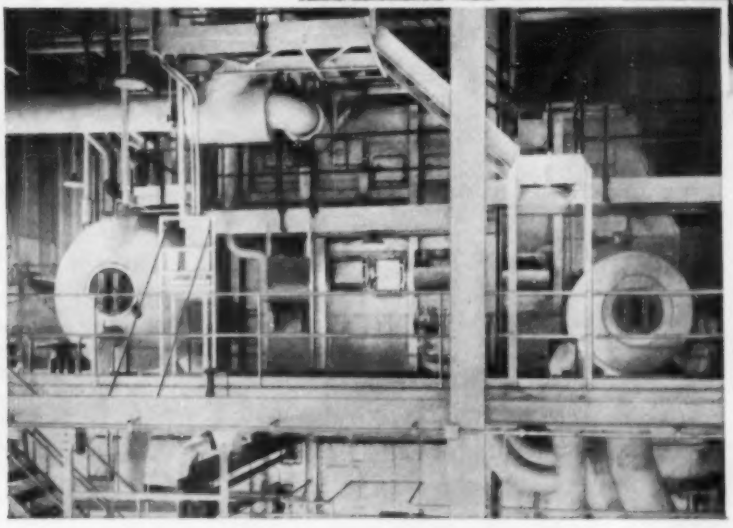
steam generators



Simplified flow diagram of typical 3-drum Dual Circulation unit. Blowdown from primary feeds continuously into secondary section. Final blowdown is from secondary drum.



KANSAS GAS AND ELECTRIC CO. recently installed these two FW Dual Circulation units at the Murray Gill Steam Electric Station. One has a capacity of 425,000 lb/hr and the other, 625,000 lb/hr —both operating at 1350 psi, 955F. Consulting Engineers were Ebasco Services, Inc.



A LARGE MID-WESTERN REFINER has installed five FW Dual Circulation Steam Generators, each unit designed for 300,000 lb/hr at 1350 psi, 900F, with 100% feedwater makeup. Photo shows upper drums of one of the five 3-drum units. Consulting Engineers were Stone and Webster Engineering Corp.

2 BIG NEW 9600 H.P.

Talk about modern power plant operation . . . visualize a comfortable, air-conditioned control room, separated from the main engine room by plate glass, in which one operator scans special gauges, panels, warning lights and push-buttons . . . and from this one station, easily controls the operation of two of the largest Diesel engines ever built in the Western Hemisphere.

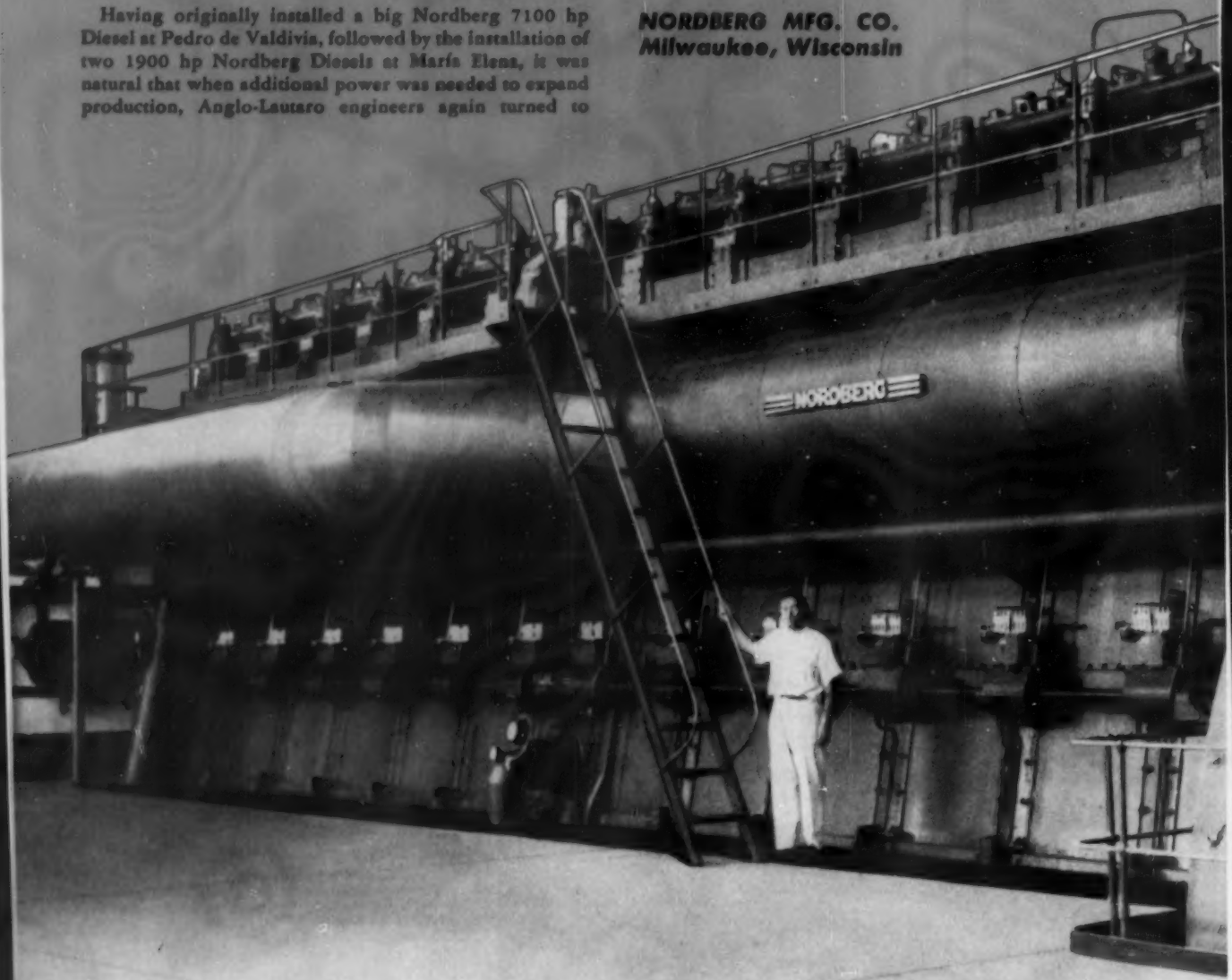
This is the story of the modern new Diesel power plant recently completed by the Anglo-Lautaro Nitrate Corporation at Coya Sur, in the heart of their vast nitrate operations, located between the María Elena and Pedro de Valdivia plants in northern Chile. The new Coya Sur power plant forms part of a three-plant network whose combined generating facilities provide a total of 46,000 kilowatts for nitrate production.

Having originally installed a big Nordberg 7100 hp Diesel at Pedro de Valdivia, followed by the installation of two 1900 hp Nordberg Diesels at María Elena, it was natural that when additional power was needed to expand production, Anglo-Lautaro engineers again turned to Nordberg for the efficient, economical solution to their current power problem.

The problem of providing the much needed additional power has now been confidently assigned to two 12-cylinder, 29" bore x 40" stroke Nordberg 2-cycle Diesel engines, each having a sea-level rating of 9,600 bhp, corresponding to 8,950 bhp at the installed altitude of 4,166 feet. Each big engine drives a totally-enclosed General Electric generator rated 8,750 kva, 7,000 kw at 80% P.F.

Employing not only two of the largest engines in the Western Hemisphere, but the most modern concepts of power plant design and operation, the new Coya Sur Diesel plant is a striking example of the way modern industry is being served by efficient, economical Nordberg Engines.

NORDBERG MFG. CO.
Milwaukee, Wisconsin

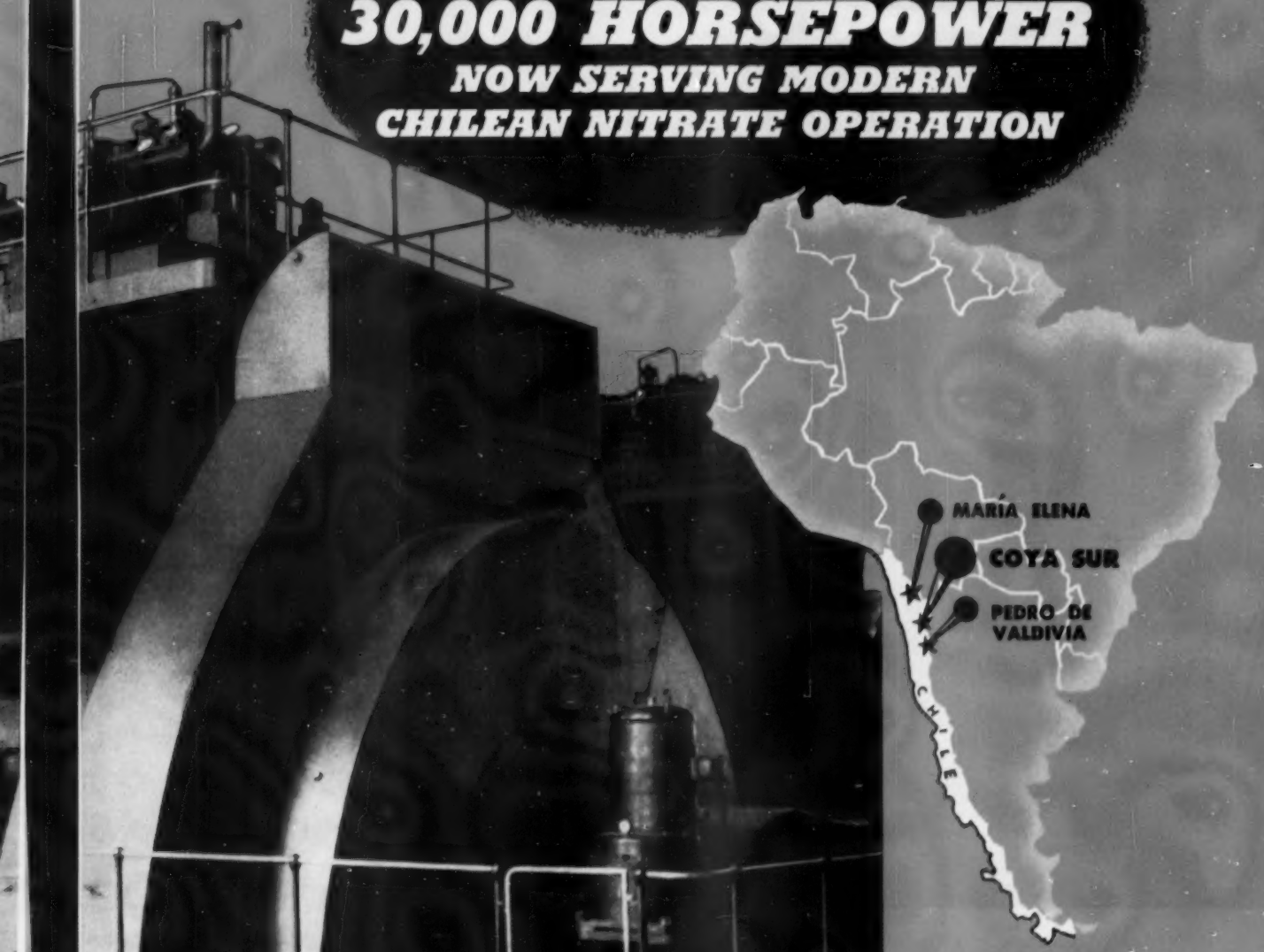


BUILDERS OF AMERICA'S LARGEST LINE OF HEAVY DUTY ENGINES . . . 10 TO OVER 10,000 H.P.

NORDBERG DIESELS

FOR ANGLO-LAUTARO NITRATE CORPORATION

FIVE NORDBERG DIESELS TOTALLING MORE THAN 30,000 HORSEPOWER NOW SERVING MODERN CHILEAN NITRATE OPERATION



NORDBERG

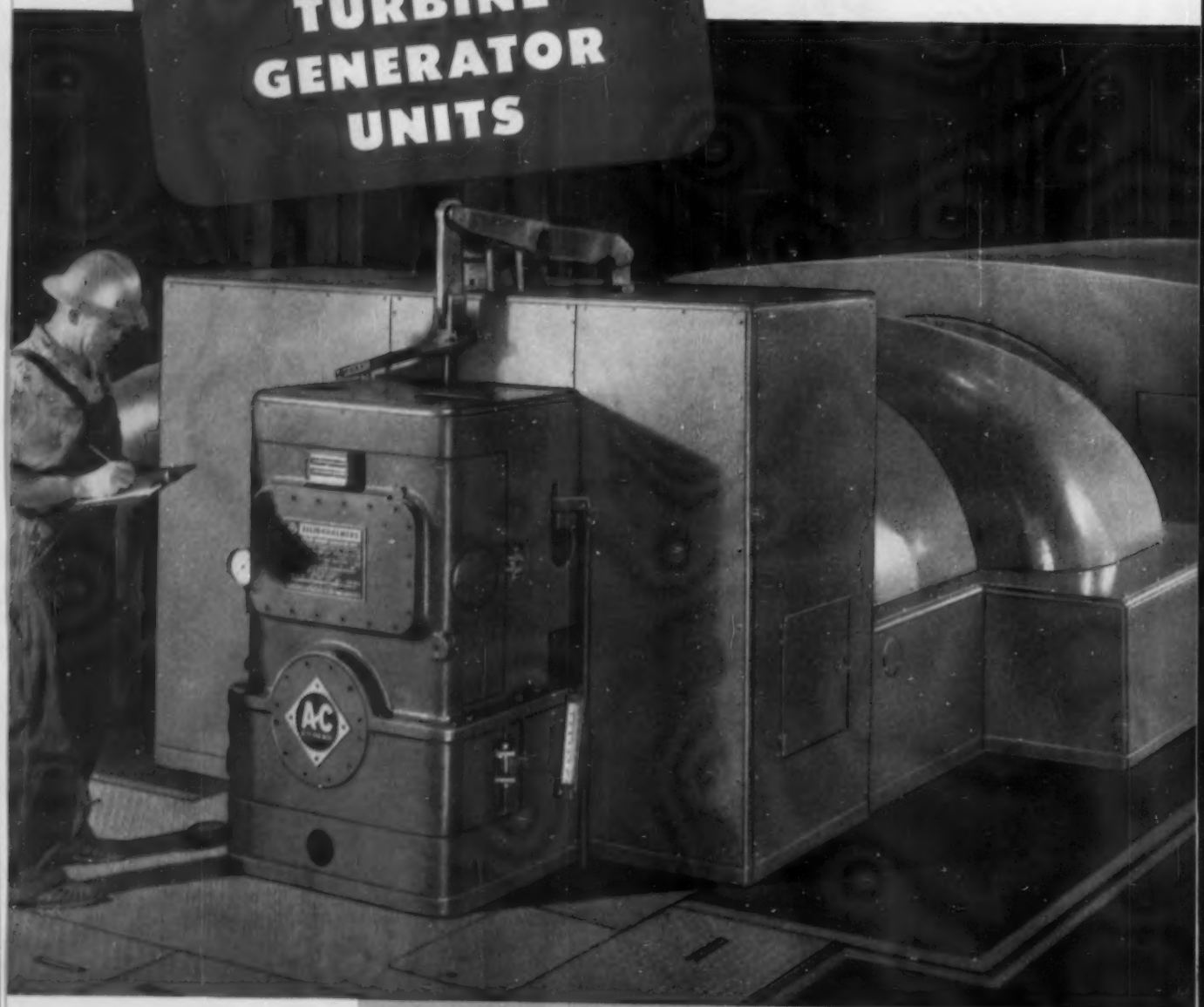
DIESEL • DUAFUEL® AND SPARK-FIRED GAS ENGINES

P634

Choice for

WA-Series

STEAM TURBINE GENERATOR UNITS



COMPLETE POWER PLANT at Tuscola includes three boilers and two WA-Series steam turbine generator units, shown above. Allis-Chalmers also supplied condensers and condensate pumps for the plant.

ALLIS-

New $44,000,000 Petro-chemical Plant

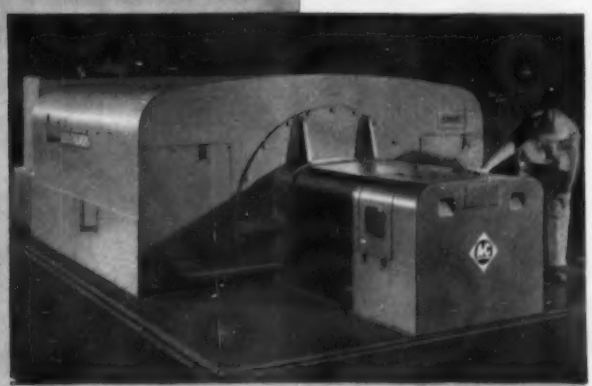
Two units generate power as by-product from steam required for processing natural gas

NATIONAL PETRO-CHEMICAL CORPORATION'S new Tuscola, Illinois, plant takes up to 425 million cubic feet of natural gas from the adjacent Panhandle Eastern pipeline, extracts 10 million cubic feet of ethane for cracking into valuable industrial chemicals, and returns the gas to the pipeline for transportation to big city customers.

To synthesize this huge amount of ethane into ethylene, hydrogen, and later into other useful components, fractionation and low temperature separation are used. The processes require 600,000 pounds per hour of steam, which is produced at 625 psig, 750 F.

Two condensing, automatic extraction WA-Series steam turbine generators are utilized to produce 10,000 kw of power from the steam before it is delivered into plant processes. The steam is delivered directly into the high temperature side of the automatic extraction impulse turbines, from which it is extracted at 65 psig for use in the plant. Each turbine generator unit is equipped with a housing-type, air-cooled generator and exciter. The entire units are carefully engineered and manufactured to operate as integrated units, 24 hours a day, 7 days a week.

WA-Series steam turbine generator units match the most modern plant design to provide high efficiency power or process steam. They are available in condensing or non-condensing types in NEMA ratings 2000 kw and larger. Bulletin 03B7654 gives complete facts. For your copy just call your nearby A-C office or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4477



OUTBOARD END of one unit shows exciter housing.

Simplified Installation and Maintenance

Every detail of WA-Series steam turbine generator units is designed for maximum simplicity and maintenance. Three-bearing construction, above-the-floor oil piping, and bracket-bearing, housing-type air-cooled generator are some of the features that result in a compact unit with simplified installation requirements. Turbine and generator are shipped with their rotors locked in place, further minimizing installation time.

Maximum reliability is assured by labyrinth spring-back steam seals throughout, removable external glands, high chrome alloy steel buckets and nozzles, and a time-proved governing system.

CHALMERS

A-C ALLIS-CHALMERS

CONTRACTING DIVISION — MIDWEST PIPING COMPANY, Inc. — ST. LOUIS, MISSOURI

JOB No. C-3550 — LINE SKETCH. — DATE MAR 4, 1953

NAME WABASH RIVER STATION — OWNER PUB. SERV. CO. IND. — LOCATION TERRE HAUTE, IND

UNIT 1

LINE Nº 101
MAIN STEAM PIPING
UNIT #1

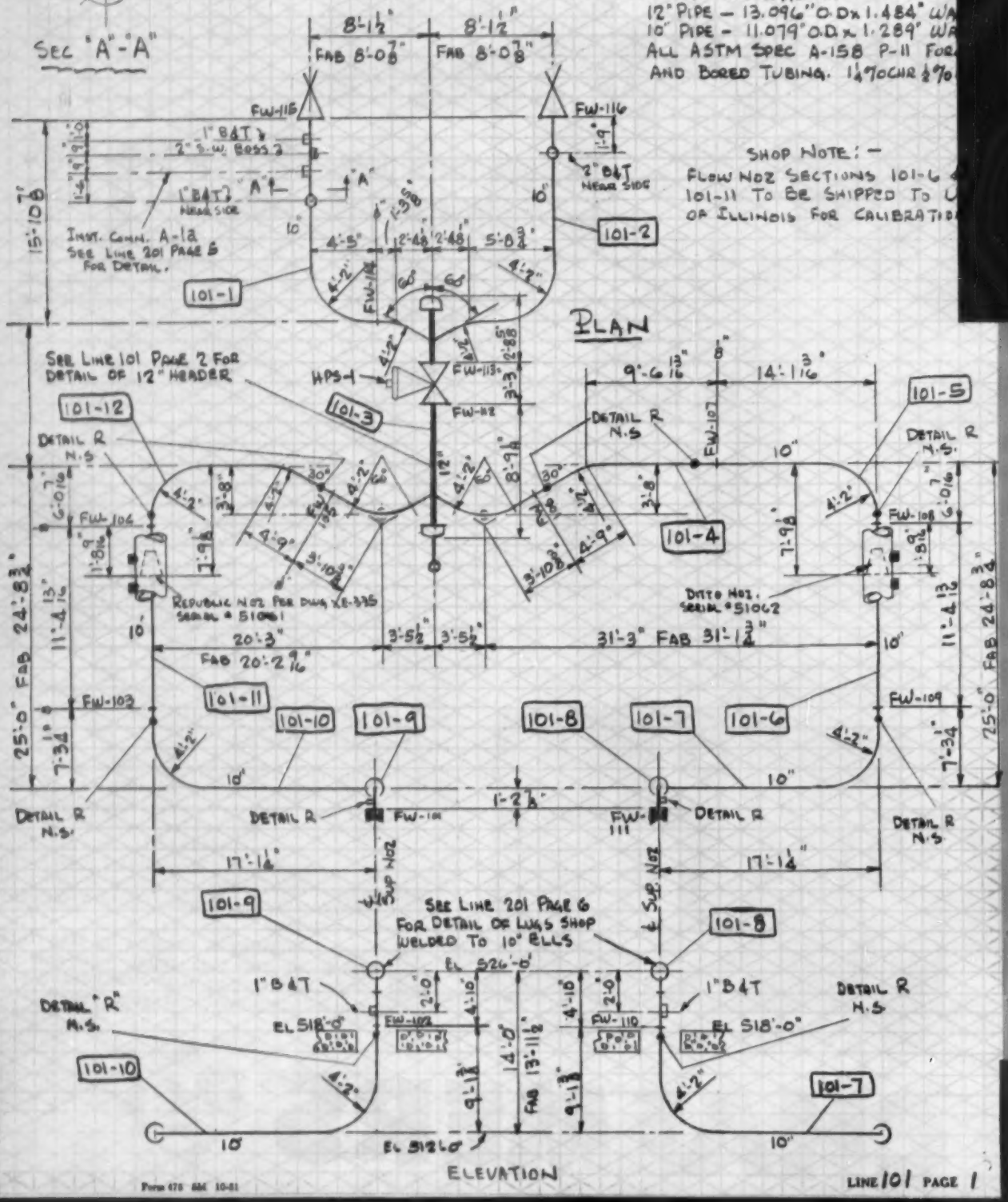
DWG M-2

2" SW Boss — 45°

SEC "A"-"A"

SPECIFICATIONS:-
12" PIPE – 13.096" O.D x 1.484" W/A
10" PIPE – 11.079" O.D. x 1.289" WA
ALL ASTM SPEC A-158 P-11 FOR
AND BORED TUBING. 1¼ %CHR ½ %

SHOP NOTE:-
FLOW NOZ SECTIONS 101-6
101-11 TO BE SHIPPED TO
OF ILLINOIS FOR CALIBRATIO



Field Erection Sketches like this HAVE Important Advantages to Users of MIDWEST PIPING

Reproduced on the page at left (about ¾ actual size) is a Field Erection Sketch typical of those prepared for all piping installed by our Contracting Division. These sketches have very real advantages for the customer.

These sketches are made by our skilled piping engineers who are thoroughly familiar with both shop fabrication and field erection. Each line is divided into a series of subassemblies that minimize and simplify the field welding . . . the difficult work is done in our well-equipped fabricating shops. Each fabricated subassembly has an individual piece mark number for easy field identification and correct sequence of erection. The fabricated subassemblies are shipped to the job in that order.

All planning has been done by our engineering staff . . . which reduces field thinking and eliminates guesswork. Erection is from these sketches instead of from the design engineer's drawings . . . this speeds up the work and results in a real cost saving and earlier completion of the job.

These Field Erection Sketches provide much essential detail that is never expected of the designer. They serve as a check of the design engineer's drawings and if discrepancies occur they are disclosed before fabrication instead of during erection.

The preparation of these Field Erection Sketches requires careful analysis of the job which often suggests changes that simplify and streamline the piping design and reduce costs in the shop and in the field.

Consequently, the customer gets a better piping job at minimum cost . . . which is why you will find it to your advantage to call in Midwest whenever you have a piping job.

MIDWEST PIPING COMPANY, INC.

Main Office, 1450 South Second St., St. Louis 4, Mo.

PLANTS: ST. LOUIS, PASSAIC, LOS ANGELES, and BOSTON

SALES OFFICES: NEW YORK 7—50 CHURCH ST. • BOSTON 27—426 FIRST ST.
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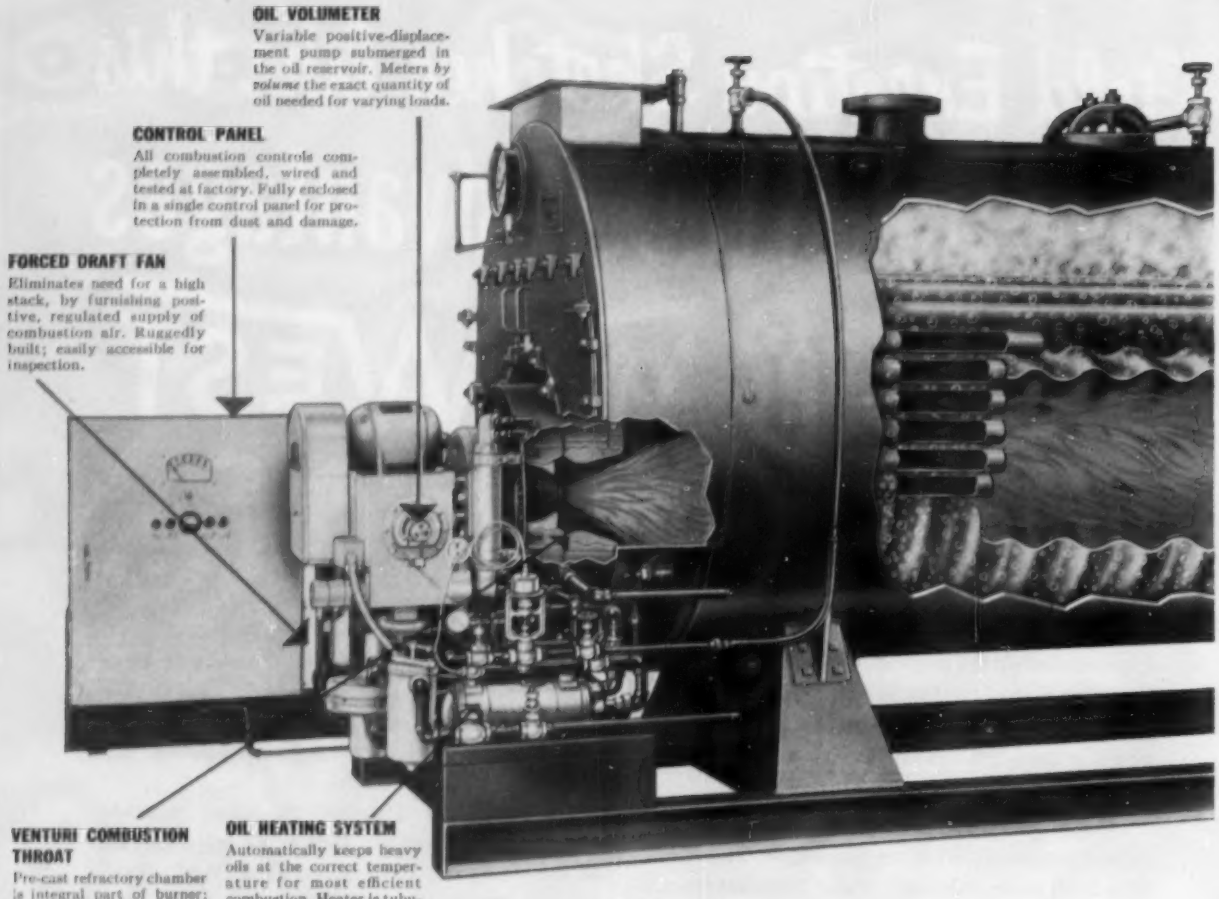
TULSA 3—224 WRIGHT BLDG.

6497

MIDWEST

PIPING FABRICATION and CONSTRUCTION

OFFERS YOU MANY BENEFITS


OIL VOLUMETER
Variable positive-displacement pump submerged in the oil reservoir. Meters by volume the exact quantity of oil needed for varying loads.
CONTROL PANEL
All combustion controls completely assembled, wired and tested at factory. Fully enclosed in a single control panel for protection from dust and damage.
FORCED DRAFT FAN
Eliminates need for a high stack, by furnishing positive, regulated supply of combustion air. Ruggedly built; easily accessible for inspection.
VENTURI COMBUSTION THROAT
Pre-cast refractory chamber is integral part of burner; eliminates on-the-job brick work.
OIL HEATING SYSTEM
Automatically keeps heavy oils at the correct temperature for most efficient combustion. Heater is tubular multiple-pass type; with temperature control instruments and necessary valves.

Perfectly balanced firing

IT HAS TO BE PLANNED

Iron Fireman firing systems are available as complete package boiler-burner units of the type shown above, or as separate package burners for installation in your present boilers.

No mere conversion burner, these package burner units contain every component for balanced firing: single or dual-fuel systems and burners, forced draft air supply, built-in combustion refractory, completely wired and tested controls.

Iron Fireman burner units are carefully assembled and tested at the factory. This means the kind of continuing dependability and operating efficiency seldom achieved with local assembly.

INSTALLATION SAVINGS, TOO

Long-range savings should be the main consideration in your choice of a firing system. But don't overlook the *installation savings* that you can also make with an Iron Fireman package burner. There's little more involved than bolting to the boiler front, and making fuel and electrical connections. Iron Fireman package burners are engineered for firing practically all types of steam and hot water boilers.

FOR OIL OR GAS, OR BOTH

Iron Fireman package burners with dual-fuel systems

THE IRON FIREMAN

Iron

OIL, GAS OR COAL

DeVilbiss plant finds that Iron Fireman complete fuel burning systems provide higher efficiency, greater cleanliness

This photograph of the DeVilbiss boiler room at Barrie, Ontario, Canada, shows two Iron Fireman boiler-burner combination units installed there last year. Officials report performance has been highly satisfactory. Installation was made by Tewes Engineering, Toronto, Ontario.

is no accident . . .

can bring greater economy to your operations in two important ways. First, you can take full advantage of seasonal fuel price cuts. And second, in event of emergency fuel shortages you can rapidly switch over *without* expensive shut-downs. Controls are actually changed from one fuel to another with just the flick of a switch!

Gas of any type is effectively burned with the Iron Fireman ring type gas burner. And the horizontal rotary oil burner, shown above, brings you steady and economical power with heat-rich heavy oils.

GET COMPLETE INFORMATION

Fuel savings . . . installation savings . . . dependable long-range operation. Certainly these features belong in *your* plant.

For complete technical information on the Iron Fireman package burner, send the coupon.

Fireman®

FIRING FOR HEATING, PROCESSING, POWER

IRON FIREMAN MANUFACTURING CO.
3043 West 106th Street, Cleveland 11, Ohio.
In Canada, write 80 Ward Street, Toronto, Ontario.

Please send detailed information on Iron Fireman package burner units for oil, gas, or oil-gas dual firing.

Name_____

Address_____

City_____ State_____

Blaw-Knox metallurgist uses optical pyrometer to check pipe temperature in shop of Power Piping Division

. . . bending an offset in heavy chrome moly pipe for main steam line of Colbert Plant

You can readily appreciate that plenty of skill plus modern shop facilities are required to bend this 19½" OD x 3" wall, 2¼% chrome, 1% molybdenum pipe to strict specifications . . . which is being done in the Blaw-Knox Power Piping shop in Pittsburgh.

For example, wall tolerances must be within plus 0.125 and minus 0.000. Forging must be turned to provide an all-around increase in thickness on offsets to compensate for thinning of walls.

When bending the pipe, temperature must be within 1750° and 1950° . . . because alloy pipe becomes difficult to bend and is subject to cracking at 1650°. After bending to specified shape, the pipe is heat-treated and ultrasonically tested with a radar-type device for detection of any defects before shipment.

In addition to the main steam line of 419 feet of heavy alloy steel piping, Blaw-Knox is fabricating all the piping for the vent, condensate, boiler feed and heater drains in the TVA Colbert Steam Generating Plant near Tuscumbia, Alabama.

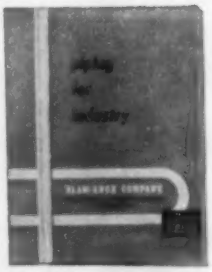
All these piping systems are being erected under the supervision of a Blaw-Knox supervisor and an engineer, on field location.

The same experience, skill and facilities of our Power Piping Division are always available to you . . . to help solve your piping problems and to quote on your requirements.

BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

Pittsburgh 33, Pa.



BLAW-KNOX

POWER PIPING

To get more information on piping for industry, write for your copy of Bulletin No. 2443.

Complete prefabricated piping systems for all pressures and temperatures . . . plus complete line of functional spring hangers • constant support spring hangers • rigid hanger assemblies • overhead roller assemblies • supports • vibration eliminators

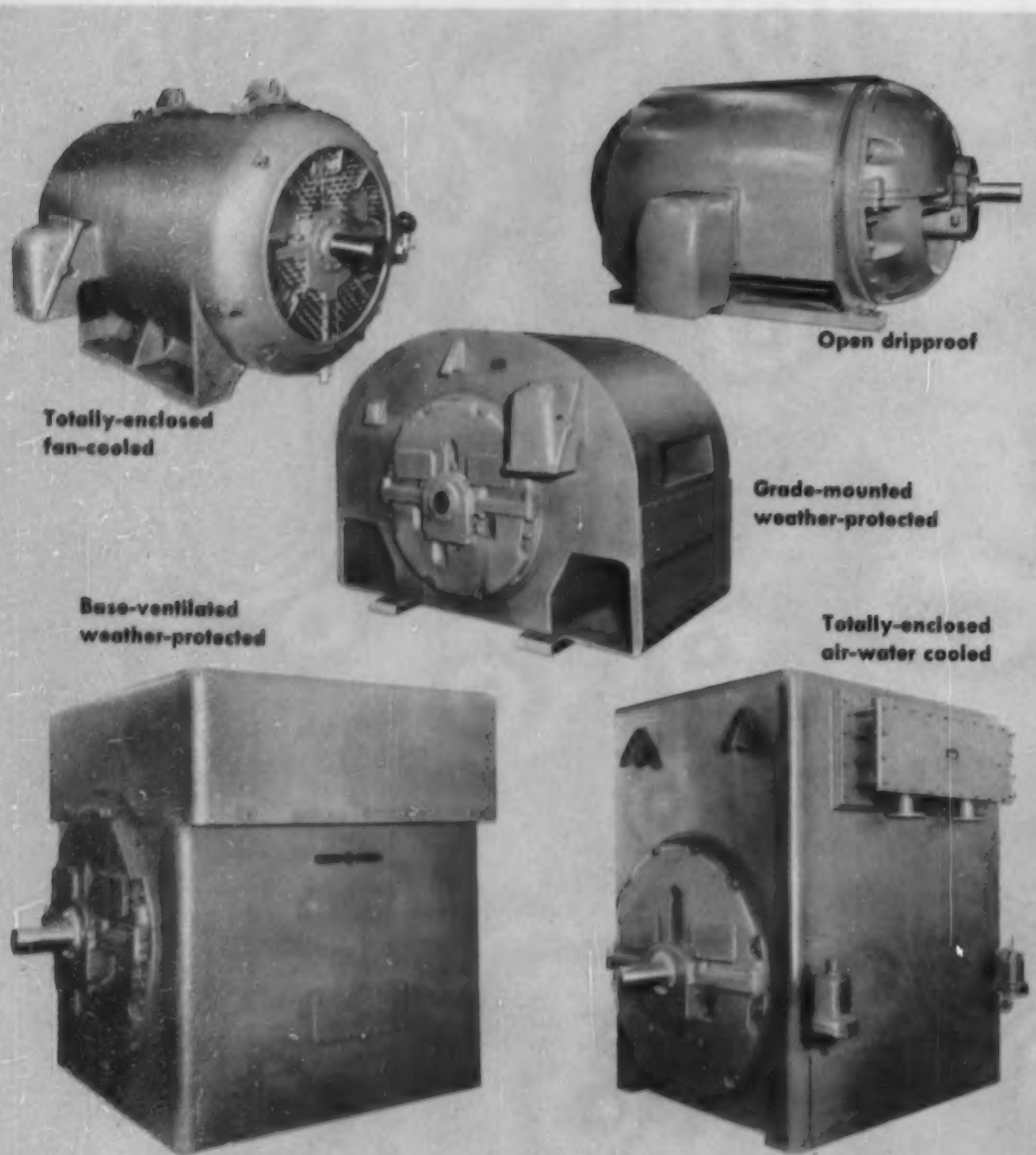
HIGH-POTENTIAL TESTS HELP PROVE . . .

NEW INSULATION MAKES G-E MOTORS LAST 50% LONGER

See Details Inside

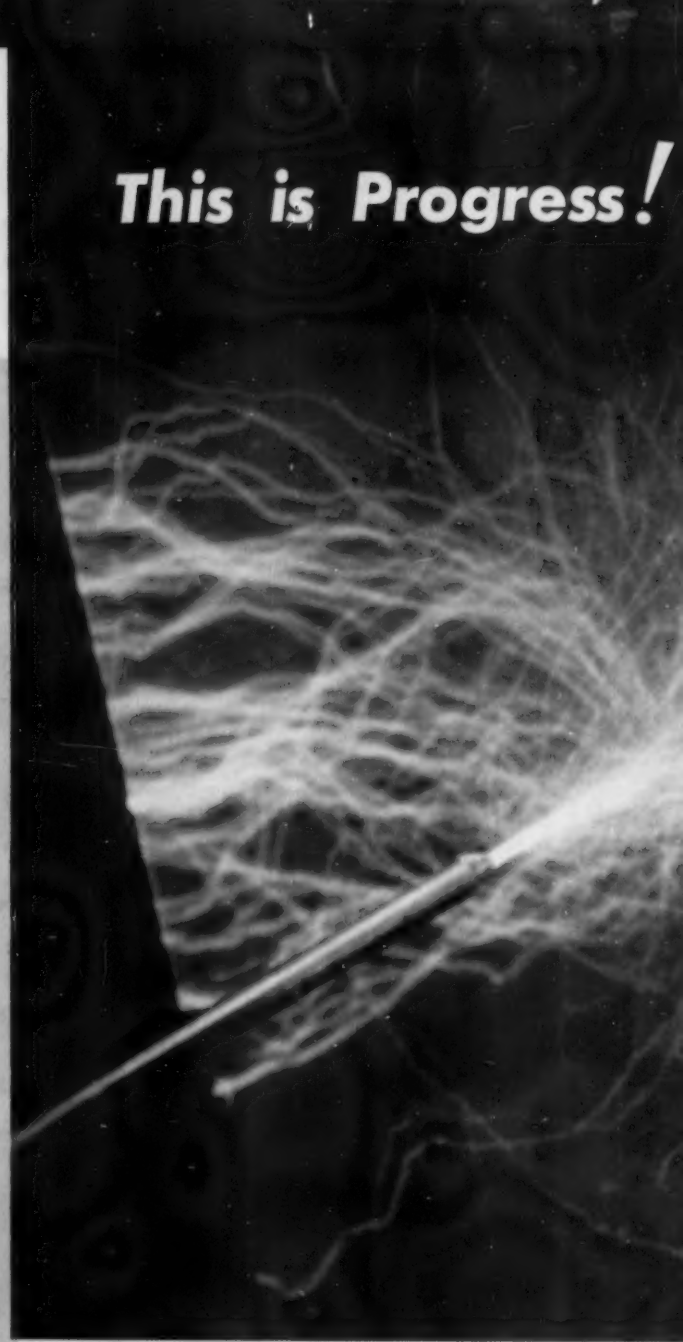
NOW AVAILABLE IN MANY RATINGS OF THESE G-E INDUCTION MOTORS

(Approximately 100 to 3000 hp)



Progress Is Our Most Important Product

GENERAL ELECTRIC



HIGH-POTENTIAL TESTS HELP PR

NEW INSULATION MOTORS LAST 5

See Details Inside

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LP PROVE...

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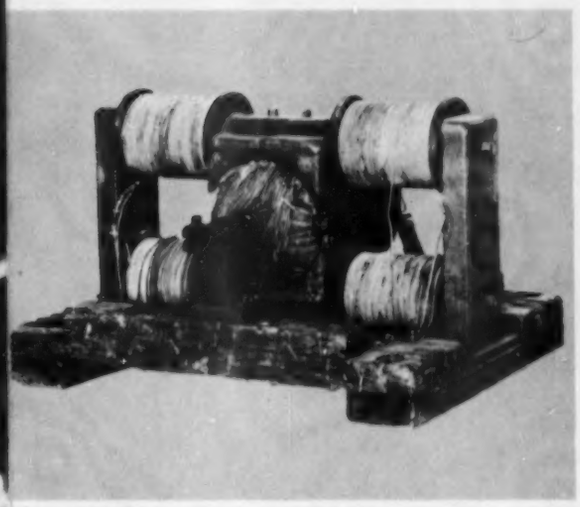
THE THIRD MAJOR STEP IN THE EVOLUTION OF FORM-WOUND MOTOR INSULATION SYSTEMS



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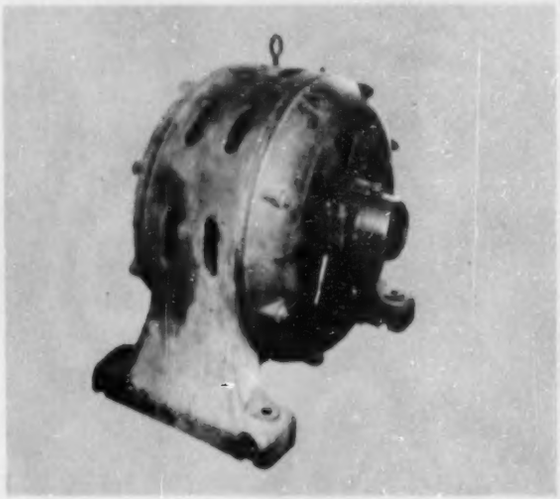

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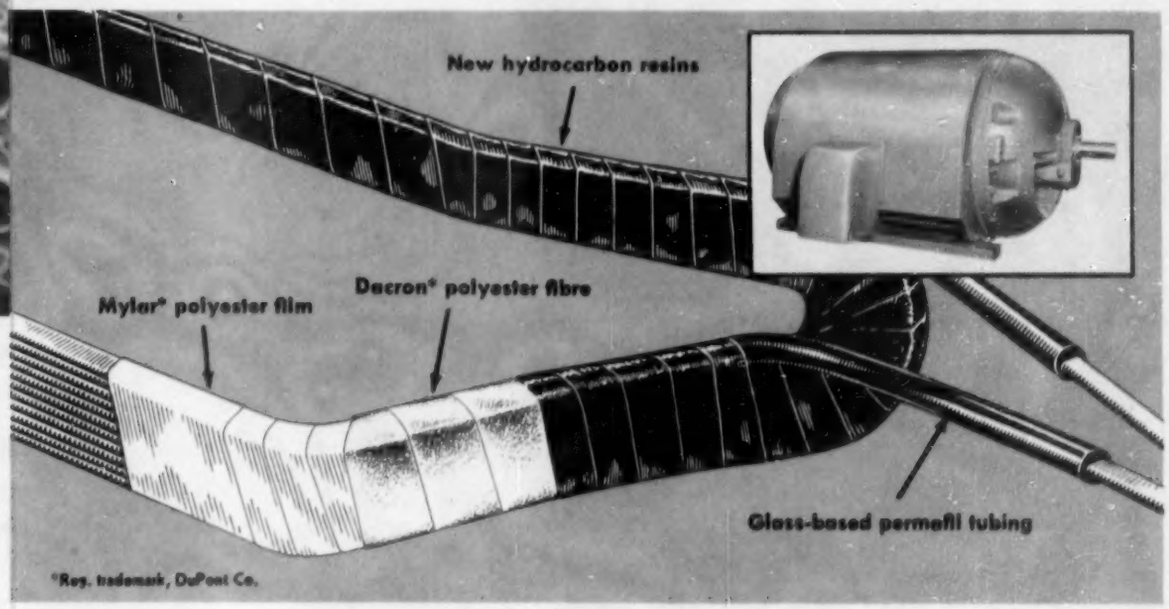

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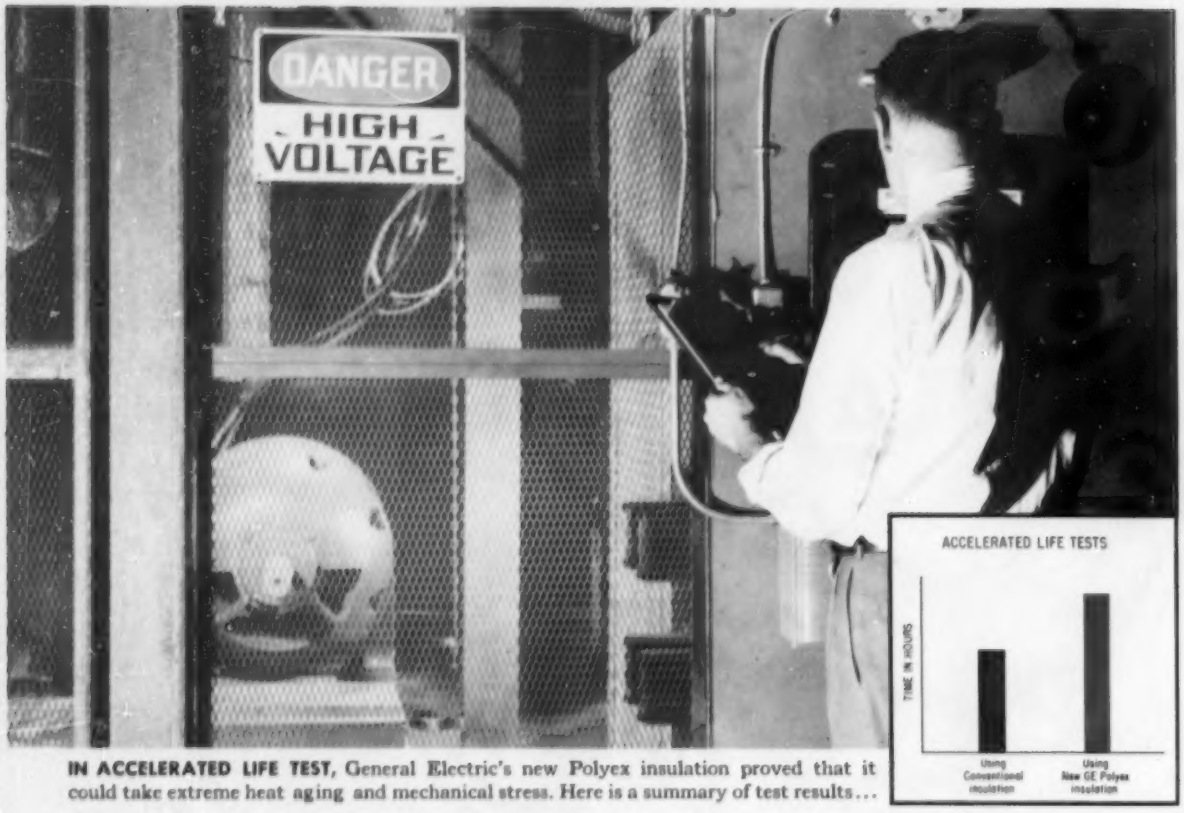
Want to keep this information? Tear along perforated edge.

50% LONGER MOTOR LIFE



IN ACCELERATED LIFE TEST, General Electric's new Polyex insulation proved that it could take extreme heat aging and mechanical stress. Here is a summary of test results...

An engineering achievemen

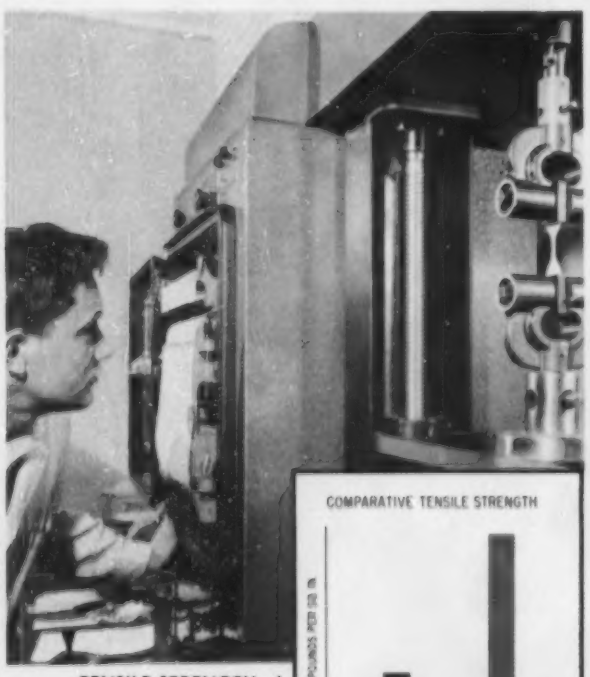
General El
That is 7

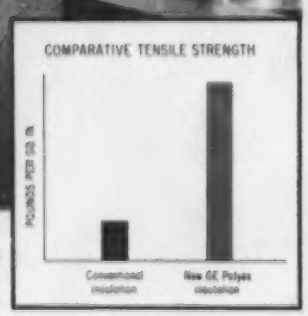
REVOLUTIONARY *POLYEX* INSUL
OF THE AMAZING PROPERTIES OF

General Electric has developed a completely new Class A insulation for form-wound coils which lasts 50% longer than other insulations in use today. Its greater ability to withstand physical and thermal stresses provides an added margin of protection that will mean tremendous savings to you because of reduced motor failures and maintenance costs.

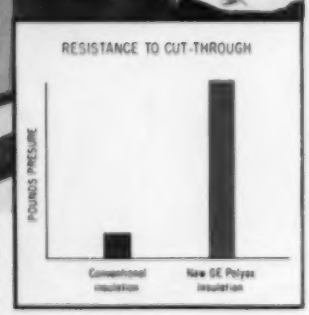
POLYEX INSULATION is a balanced system of polyester films and fibres, together with new hydrocarbon resins. Materials in new Polyex insulation have high dielectric and physical

7 TIMES GREATER PHYSICAL STRENGTH



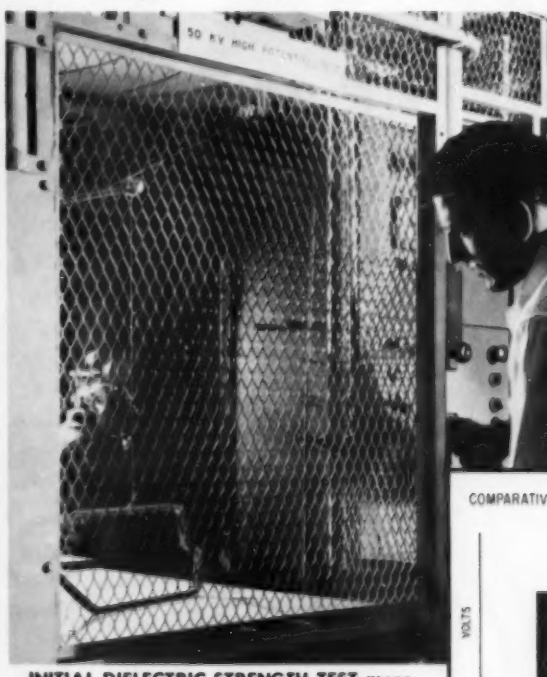


TENSILE STRENGTH of new insulation offers a greater protection against physical stress.



CUT-THROUGH STRENGTH, seven times greater than conventional insulation, is another reason for long life.

50% MORE DIELECTRIC



INITIAL DIELECTRIC STRENGTH TEST measures insulation's ability to withstand operating and starting voltages, and the protection offered against insulation failure.

vement of vital importance to users of motors with form-wound coils . . .

Electric Develops New Insulation for Motors
s 7 Times Tougher, Adds 50% to Motor Life

Y INSULATION TAKES FULL ADVANTAGE ES OF NEW POLYESTER FILMS AND FIBRES

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physical

strength. For the first time, the cotton and paper-based tapes and sheets in conventional insulations have been eliminated.

RESULTS OF EXHAUSTIVE TESTS on new Polyex insulation are summarized on these pages.

Insulation qualities like these offer you tremendous savings in motor maintenance and a greater degree of service continuity than ever before possible.

GENERAL ELECTRIC RESEARCH for better insulation is a continuing program. Polyex insulation is the latest result of that program. Three years of intensive development and testing of materials and manufacturing techniques culminated in the most significant advance in large motor insulation in 45 years.

POLYEX INSULATION IS NOW AVAILABLE in many ratings of General Electric induction motors in the range of 100 to 3000 HP—and at no extra cost.

YOUR G-E SALES REPRESENTATIVE has complete information. Contact him at your nearby General Electric Apparatus Sales Office. *General Electric Company, Schenectady 5, New York.*

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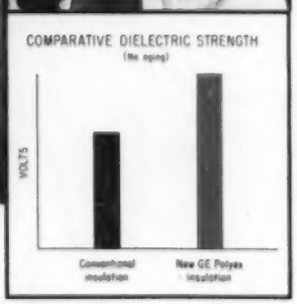
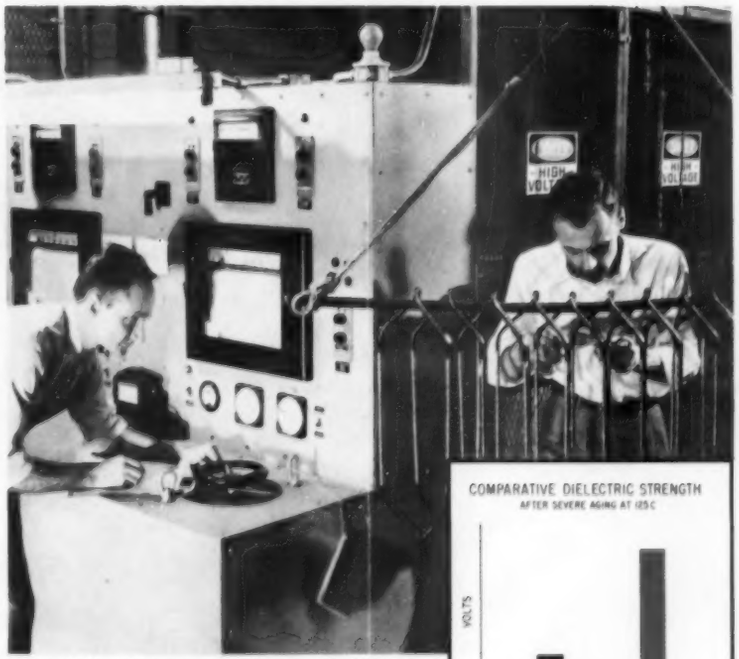
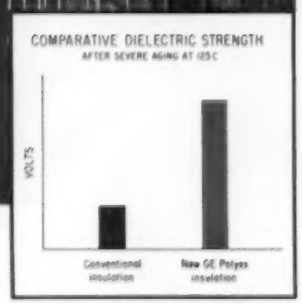
CTRIC STRENGTH, EVEN AFTER HEAT AGING



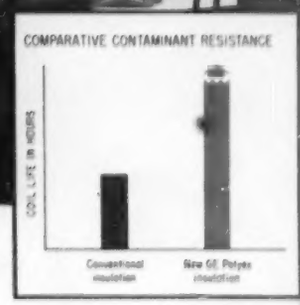


BAKED FOR THOUSANDS OF HOURS at 125°C, Polyex insulation was tested again. It proved that it retains its higher physical and dielectric properties after heat aging.



CONTAMINANT RESISTANCE DOUBLED

IN SALT SOLUTION, insulation's ability to resist contaminants was tested. Polyex-insulated coils were still operating long after conventional coils had failed.



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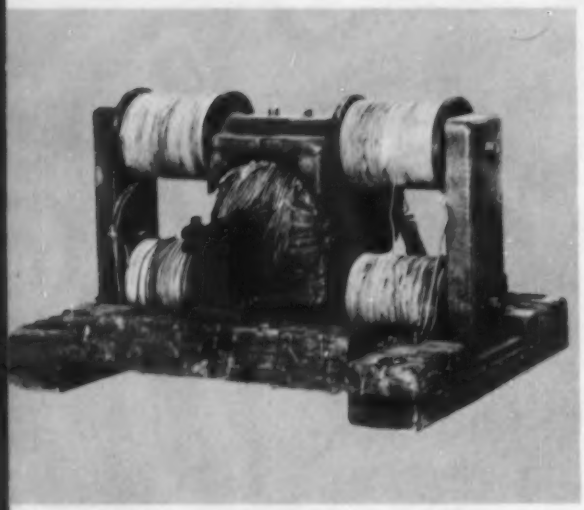

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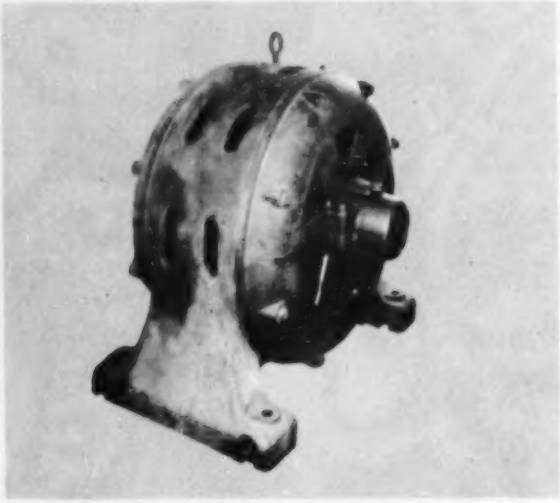

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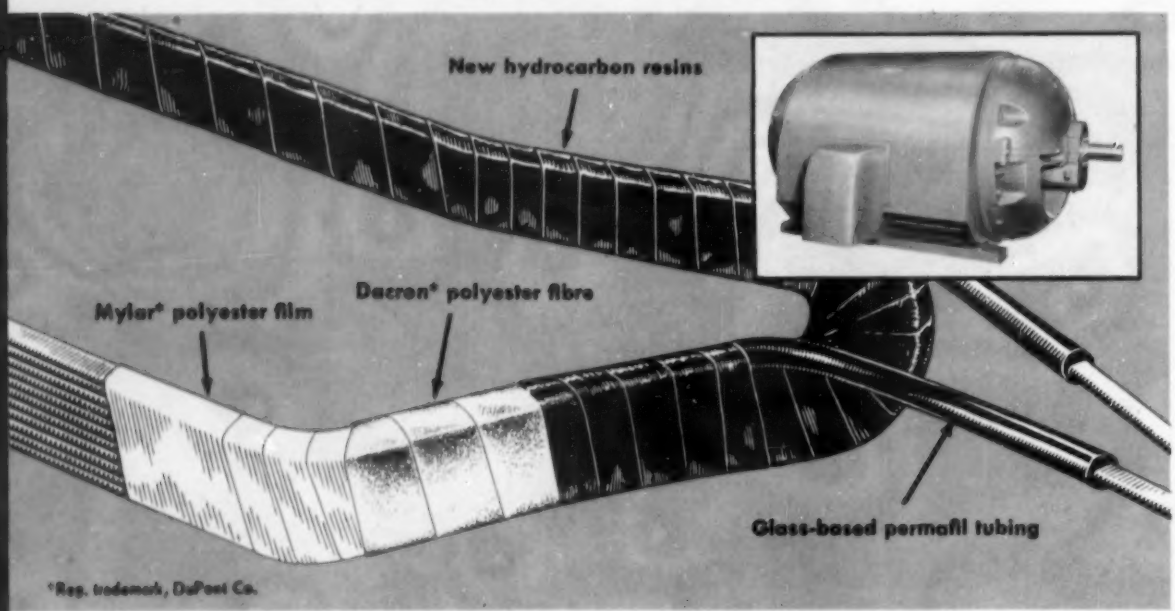

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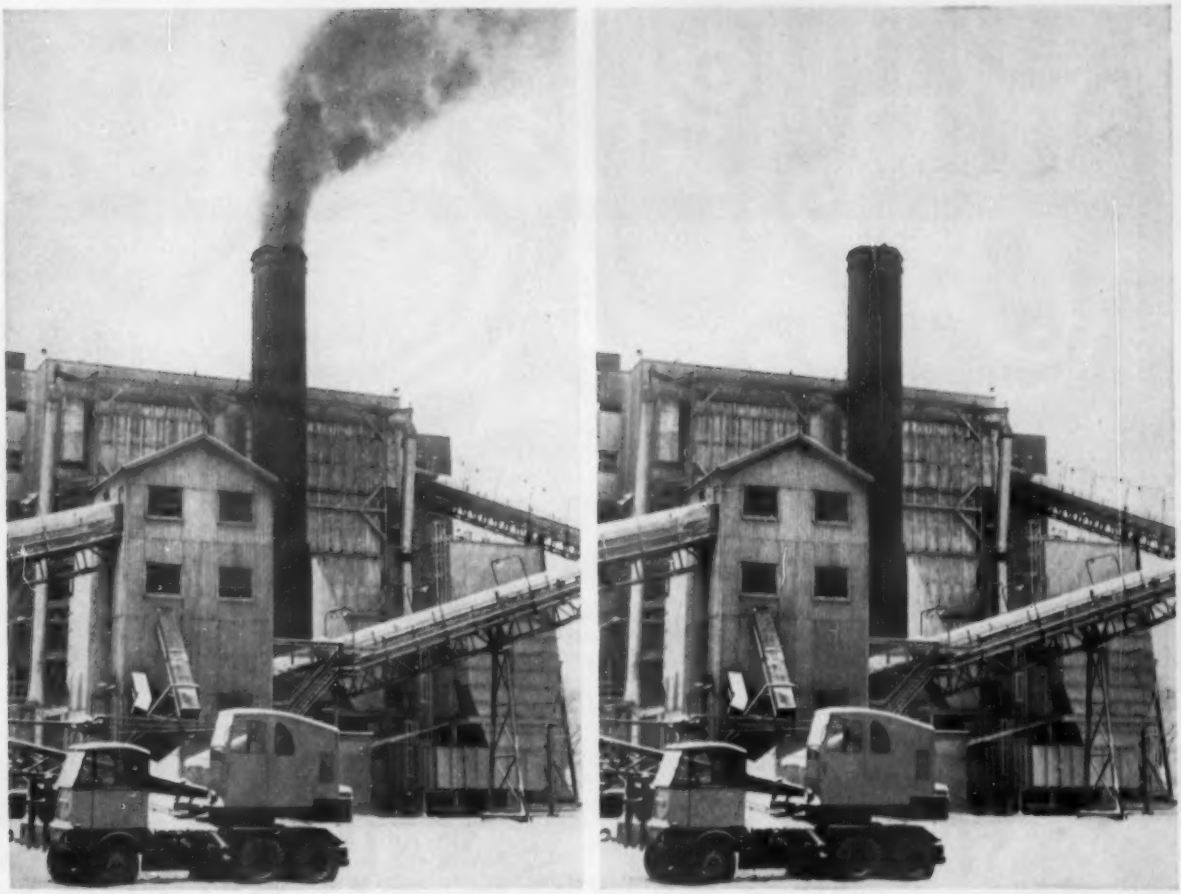

Fly Ash Problem Solved By Central Station

This Pennsylvania utility felt that as long as you can *see* dirty stack discharge, you have a problem. To solve it, they decided to insist on fly ash collection equipment with very high efficiency.

The electrical precipitators they chose, which were placed after existing mechanical collectors, are Cottrells, designed and built by Research-Cottrell. Their effectiveness is demonstrated in the above unretouched photographs. At the left, the precipitators were turned off long enough to take the picture showing the volume of fly ash discharged by the boilers. At the right, the precipitators are turned back on. Stack discharge is visually clean.

This is another example of industry's trend toward establishing its own higher standards for nuisance abatement. Research-Cottrell, which has made more fly ash installations than any other company, cites the following comparison:

In the period from 1923 to 1939 only 11% of its power plant customers specified fly ash collection efficiency of 95 to 98%. In recent years, that 11%,has risen to fully 90%.

One reason, of course, is the generally increasing emphasis on community relations. Another factor is that farsighted companies are anticipating stricter smoke regulations. They are anxious to install equipment that will end their smoke problems now and also prevent such problems from occurring in the future.

Still another factor is this. In recent years, with modern coal pulverization and advanced boiler design, there has been an increase in the fineness of fly ash particles. This calls for the most efficient equipment available.

Read—in Bulletins FA and MI—about Cottrell equipment and the Research-Cottrell's MI Rapper. This device eliminates rapping puffs and enables the precipitator to maintain, continuously, its high collection efficiency. Write for your copies today.

RC-183

RESEARCH-COTTRELL, INC.

A WHOLLY OWNED SUBSIDIARY OF RESEARCH CORPORATION

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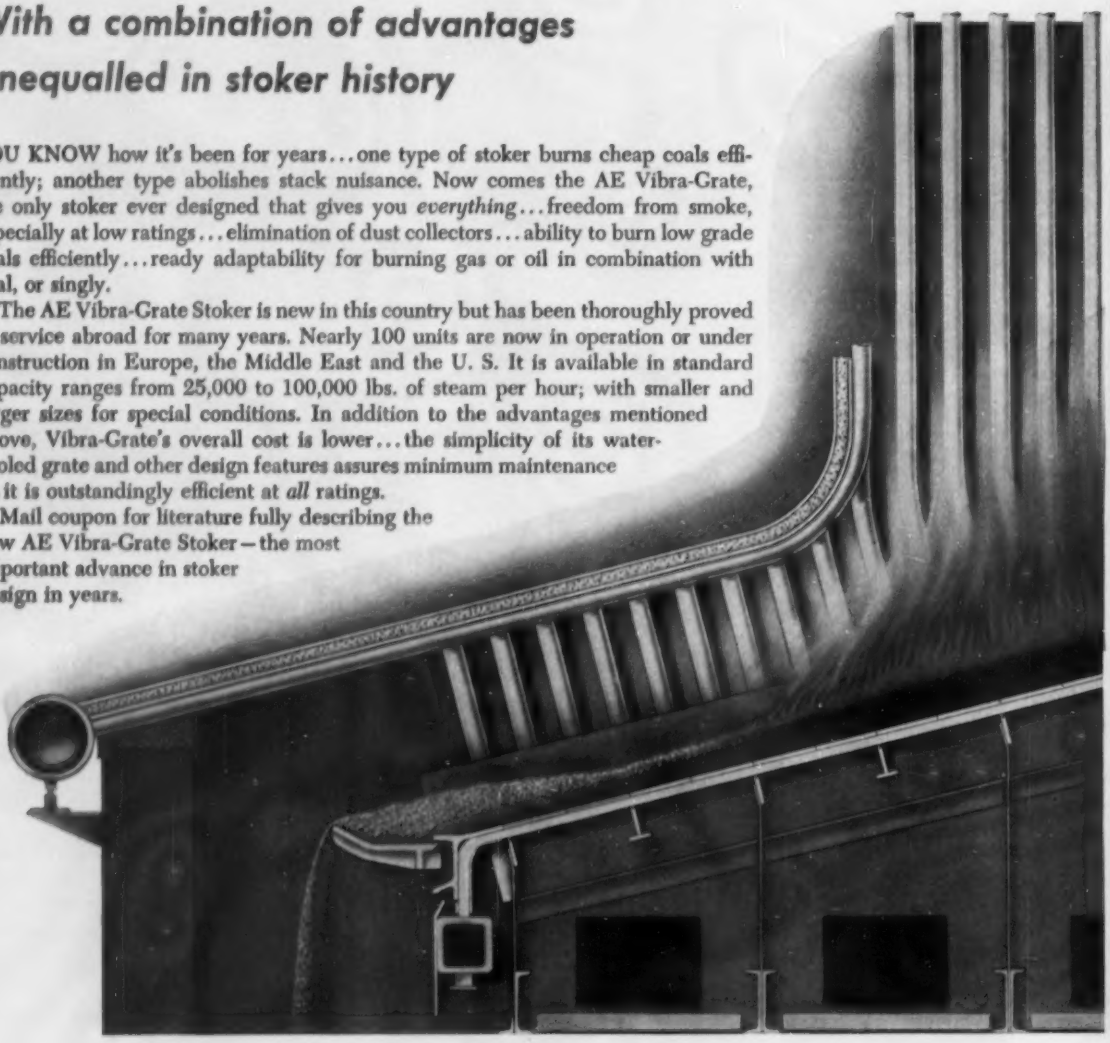
ANNOUNCING AE

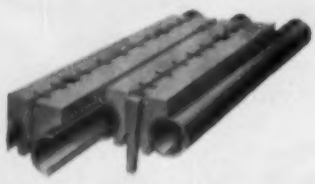
With a combination of advantages unequalled in stoker history

YOU KNOW how it's been for years... one type of stoker burns cheap coals efficiently; another type abolishes stack nuisance. Now comes the AE Vibra-Grate, the only stoker ever designed that gives you *everything*... freedom from smoke, especially at low ratings... elimination of dust collectors... ability to burn low grade coals efficiently... ready adaptability for burning gas or oil in combination with coal, or singly.

The AE Vibra-Grate Stoker is new in this country but has been thoroughly proved in service abroad for many years. Nearly 100 units are now in operation or under construction in Europe, the Middle East and the U. S. It is available in standard capacity ranges from 25,000 to 100,000 lbs. of steam per hour; with smaller and larger sizes for special conditions. In addition to the advantages mentioned above, Vibra-Grate's overall cost is lower... the simplicity of its water-cooled grate and other design features assures minimum maintenance ...it is outstandingly efficient at *all* ratings.

Mail coupon for literature fully describing the new AE Vibra-Grate Stoker—the most important advance in stoker design in years.

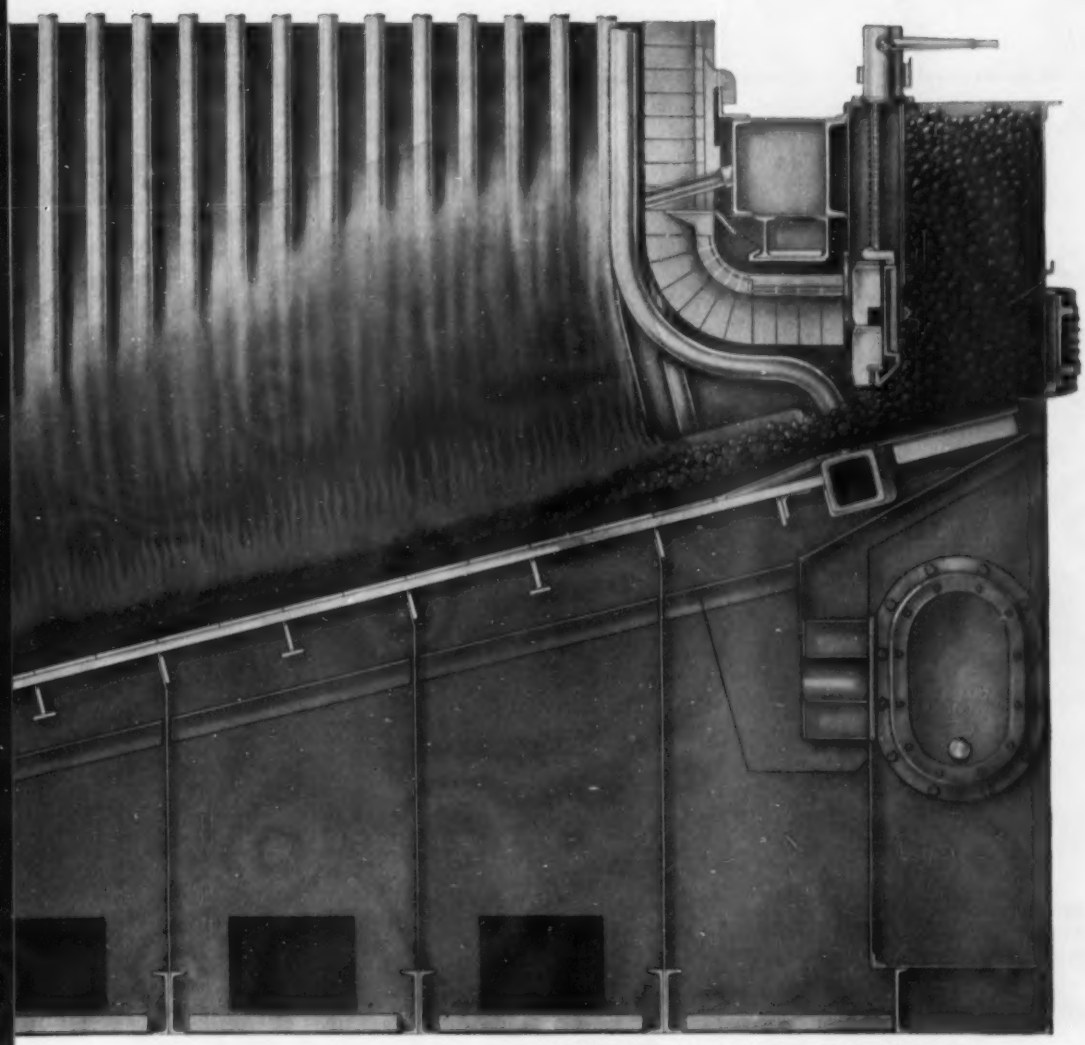




WATER TUBE SECTION—
showing mounting of grate blocks.

VIBRA-GRATE STOKER

(COMPLETELY WATER-COOLED)



AE Vibra-Grate Stoker... licensed in U.S. and Canada by L. & C. Steinmuller, GMBH, Gummersbach, Germany.

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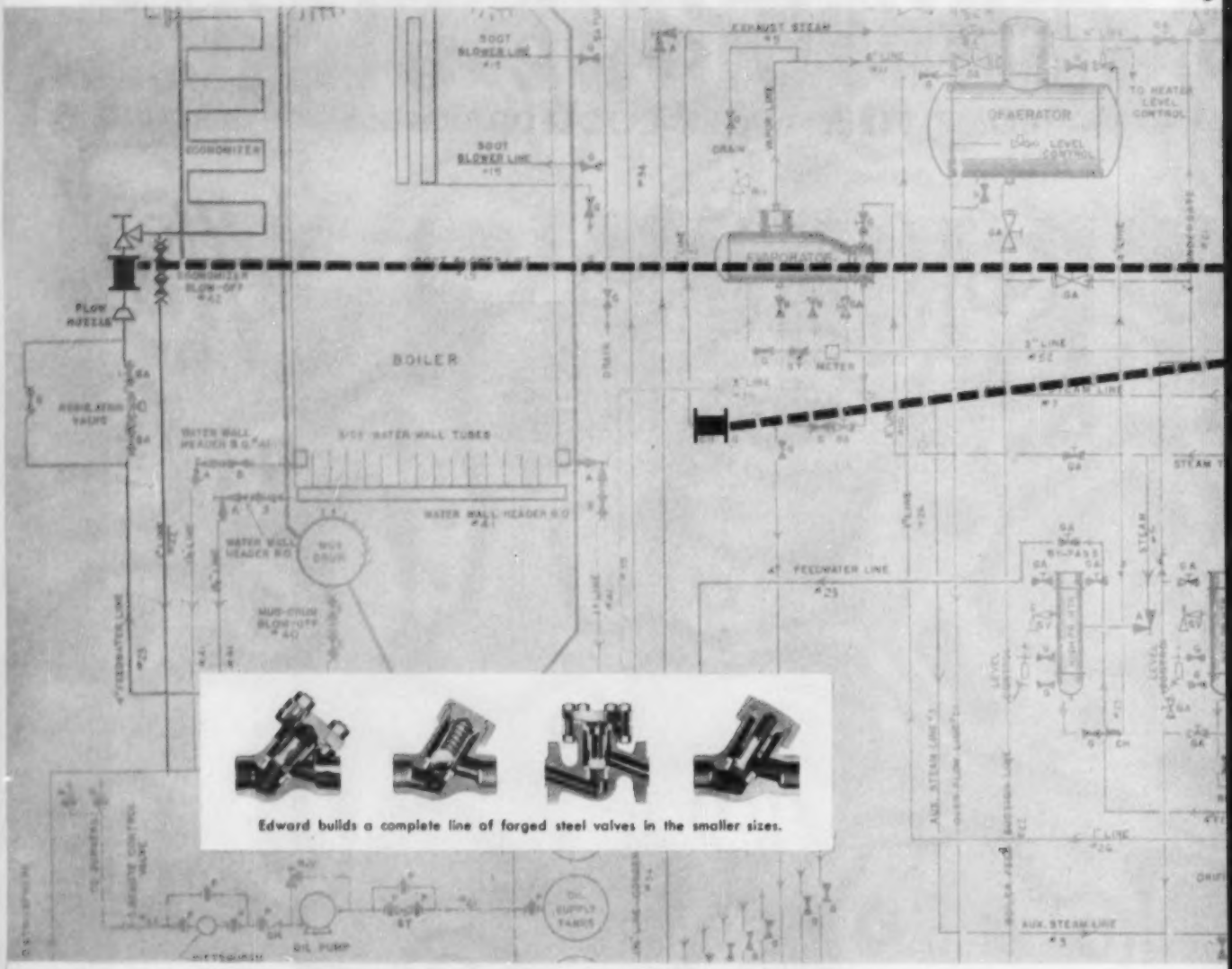
AE Products are: Taylor, Perfect Spread and Vibra-Grate Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydromite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers.

American Engineering Company
2400 Aramingo Ave., Philadelphia 25, Pa.

Gentlemen:—Please send me literature describing the new AE Vibra-Grate Stoker, the stoker that has *everything!*

Name.....Title.....
Company.....
Address.....
City.....Zone.....State.....

What you should know about



Edward builds a complete line of forged steel valves in the smaller sizes.

In the 50 years since Edward designed and first built steel valves, experience and research have revealed many facts about check valves. Here are some of the most important.

SELECTION POINTERS . . . that will improve your check valve efficiency.

1 The proper size valve is the most economical. Too small a valve has a high pressure drop and wastes power. Too large a valve requires unnecessary effort to operate and disks may hug the valve seat at low flow causing vibration and excess wear. (Edward Bulletin No. 12H describes a simple method for computing correct check valve size.)

2 In selecting check valves, the piston type has at least five big advantages over the swing type:

(a) dashpot action of piston type check valves prevents slamming—eliminates damaging shock;

(b) disks give a tighter seal;

(c) more complete guiding minimizes vibration of moving parts;

(d) angle designs to replace elbows are possible in piston type check valves;

(e) disks can be easily re-lapped when necessary.

3 In higher pressure steam generating plants, Pressure-Seal bonnet designs are rapidly replacing the cumbersome, heavily-bolted bonnets. Here are several especially desirable features:

(a) pressure-seal bonnets stay tight regardless of temperature-pressure variations;

(b) fewer bolts, lighter covers and bonnets reduce maintenance costs;

(c) pressure-seal offers a higher degree of part interchangeability;

(d) lower pressure drop in streamlined pressure-seal designs permit use of smaller piping and valves . . . saving space, weight and costs.

(e) and pressure-seal construction improves streamlining which reduces wear-inducing turbulence;

(Edward has built PRESSURE-SEAL valves for ten years and its continuing research has developed many new features that reduce maintenance and improve sealing qualities.)

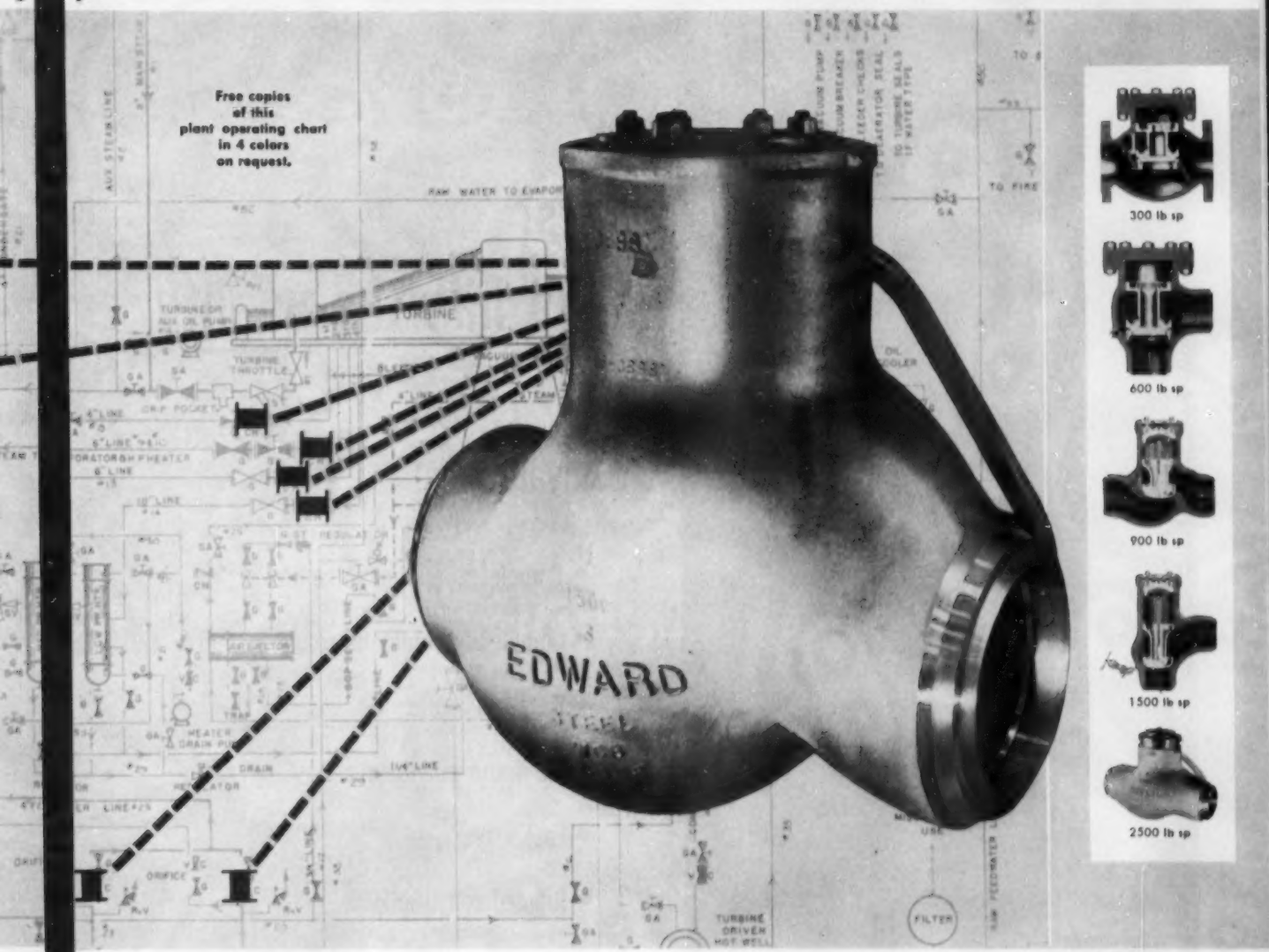
4 High pressure check valves with equalizers require less flow to open. An equalizer is a by-pass which connects the relatively high pressure zone above the disk to the high velocity, low pressure area in the valve outlet creating a semi-vacuum which pulls disk upward. (Every Edward check valve over 600 psi has an Equalizer installed on the right side when facing outlet and the disk seats itself against cover for vibrationless operation and minimum pressure drop.)

5 Avoid gadgety designs that obstruct flow and tend toward increased maintenance. (Edward check valves are simple. Internal contours are streamlined for free flow. Disk is accurately guided by three smooth, self-scouring, integrally cast ribs that insure perfect closures and full, easy openings.)

6 "Cushion closing" check valves protect piping from hammer damage and reduce wear. (Edward "piston" check valves are designed for quick "cushion closing" without damaging shock.)

7 In severe services, integral seats eliminate the possibility of leaks behind screwed or welded-in seat rings. (Edward check valves above 600 psi all have integral Stellite hard surface seats applied in a continuous ring directly to the valve body.)

CHECK VALVES*



BOILER CODE REQUIREMENTS . . . that control check valves:

P-317

(a) The feed pipe shall be provided with a check valve near the boiler and a valve or cock between the check valve and the boiler, and when two or more boilers are fed from a common source, there shall also be a globe or regulating valve on the branch to each boiler between the check valve and the source of supply. Wherever globe valves are used on feed piping, the inlet shall be under the disk of the valve. (Edward globe and gate valves are designed especially for these services.)

(b) When the supply line to a boiler is divided so as to feed a drum in more than one place or to feed more than one drum, it is recommended that each such branch line be equipped with a stop and a check valve even though the common source is equipped as required by (a).

(c) If a boiler is equipped with duplicate feed arrangements, each such arrangement shall be equipped as required by the rules.

(d) A combination stop-and-check valve in which there is only one seat and disk, and a valve stem is provided to close the valve when the stem is screwed down, shall be considered only as a stop valve, and a check valve shall be installed as otherwise provided. (Edward separated type stop-check valves have two separate disks and seats combined in one body.)

(e) Where an economizer or other feedwater-heating device is connected directly to the boiler without intervening valves, the feed valves and check valves required shall be placed on the inlet of the economizer or feedwater-heating device.

A-61 FEED PIPING

The feed pipe of a steam boiler operated at more than 15 psi maximum allowable working pressure shall be provided with a check valve near the boiler and a valve or cock between the check valve and the boiler, and when two or more boilers are fed from a common source there shall also be a globe valve on the branch to each boiler between the check valve and the source of supply. When a globe valve is used on a feed pipe, the inlet shall be under the disk of the valve. (Edward builds globe, check and gate valves designed for these services.)

INSTALLATION IDEAS . . . that foster dependable check valve operation.

1 When installing piston type check valves always have disk traveling in a vertical plane to minimize danger of "hanging-up" or incomplete closures.

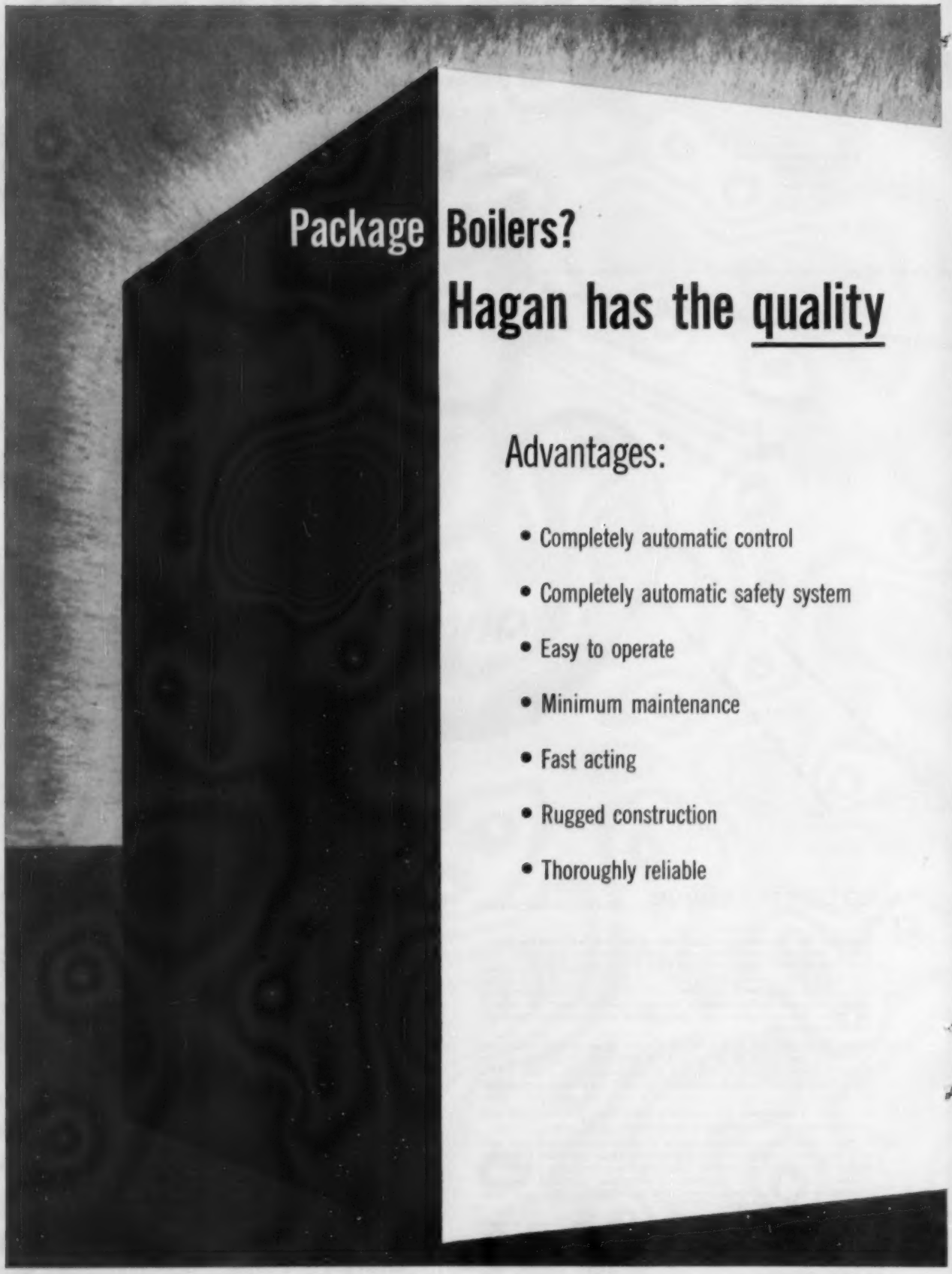
2 Never use a horizontal check in a vertical position.

3 Angle valves often save money as well as installation time when used in place of an elbow.

4 Always install check valves with enough clearance so that cover may be removed for maintenance or repairs.

**One of a series providing condensed information on valve applications in steam power plants.*

Edward Valves, Inc.
Subsidiary of ROCKWELL MANUFACTURING COMPANY
1230 W. 145th STREET
EAST CHICAGO, INDIANA
Another Product



Package Boilers?

Hagan has the quality

Advantages:

- Completely automatic control
- Completely automatic safety system
- Easy to operate
- Minimum maintenance
- Fast acting
- Rugged construction
- Thoroughly reliable

package control to fit your boiler!

Hagan offers a quality control system for your packaged boiler. The Hagan pneumatic Combustion Control System is combined with an automatic and programmed ignition system, both containing adequate safety interlocks. The whole is integrated into a factory pre-assembled and tested control center. Hagan pneumatic systems are easy to operate, will last as long as the boiler, and give you complete control and records.

Each of the six Hagan Control Packages is engineered to meet "big boiler" standards, both in respect to accuracy of control, and to dependability. All of the systems are . . .

SAFE

The safety system is complete, and so integrated with combustion control that the boiler *cannot* be operated, or if in operation, will *automatically* shut down and set off alarms, if a dangerous condition exists with respect to excessive steam pressure, low water level, low oil pressure or temperature, low gas pressure, low wind box pressure or any electric failure.

AUTOMATIC

Both combustion control system and the safety system are entirely automatic . . . here is practical "pushbutton" operation. The system is rugged and extremely simple to operate and adjust. Specialized personnel or test and maintenance equipment is not needed. A Hagan system is fast, and will function efficiently with minimum attention and minimum maintenance.

EFFICIENT

Hagan Automatic Combustion Control provides the most favorable fuel burning efficiency. Since annual fuel costs can easily exceed the total cost of boiler and controls, the gain in efficiency with Hagan control will insure maximum return on the investment in a really complete control system. Hagan Systems are designed to produce high combustion efficiency.

● *Write for Hagan Bulletin No. MSA 128 for the full story on Package Boilers and Hagan Package Control Systems.*

Specify Hagan Quality Control for Your Package Boiler!

HAGAN HALL BUROMIN CALGON

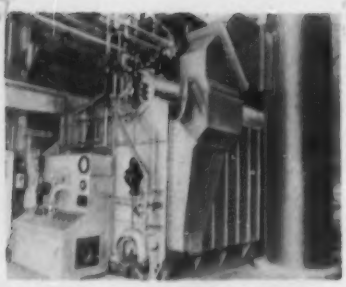
HAGAN CORPORATION

Hagan Building • Pittsburgh 30, Pennsylvania

Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Metallurgical Furnace Control Systems Control Systems for Aeronautical and Automotive Testing Facilities

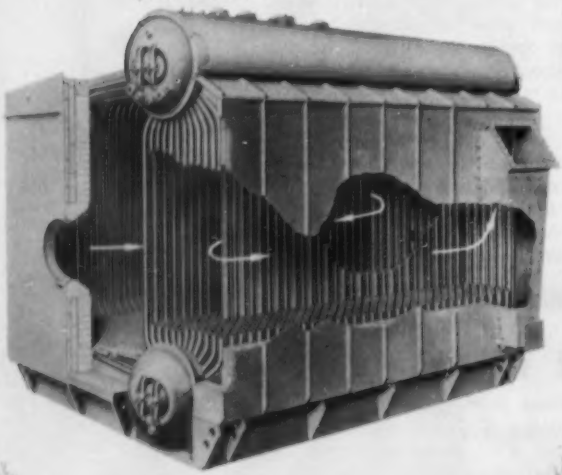
now...Combustion's VP Boiler with a

NEW LOOK



Industrial installation of VP Boiler in the South. Capacity — 33,000 lb steam per hr; design pressure 250 psi.

Cutaway view showing arrangement of two-pass VP Boiler.

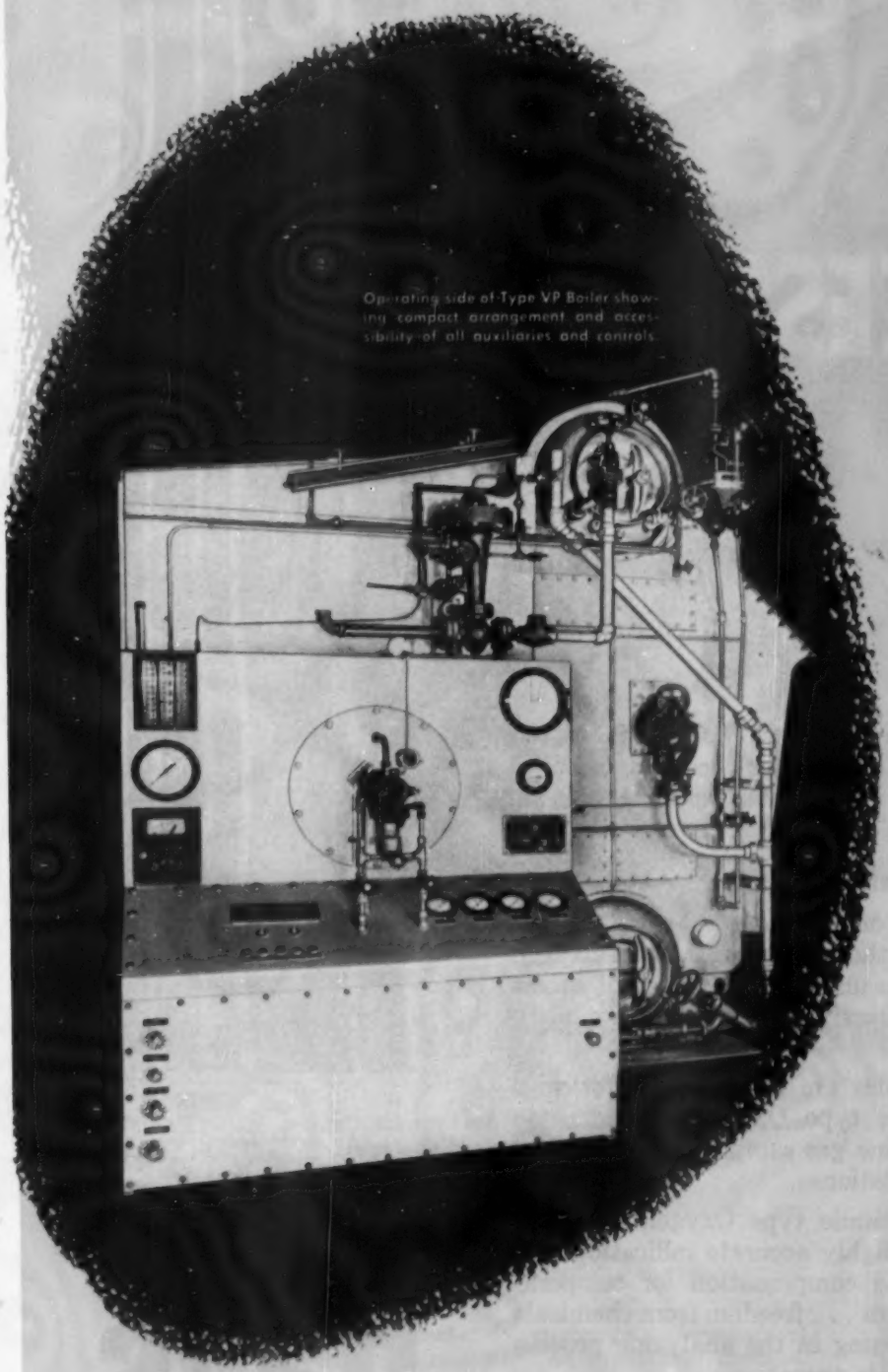


gives you more steam per dollar!

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

STEAM GENERATING, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE



Operating side of Type VP Boiler showing compact arrangement and accessibility of all auxiliaries and controls.

Combustion's well known C-E Package Boiler, Type VP, has a *new look*... outside and inside!

Outside. The VP's exterior is more streamlined, more compact. The controls and fan are now an integral part of the boiler front. Duct work is simplified. This means better appearance, easier maintenance, better operation.

Inside. Now instead of 2" diameter tubes you'll find 2½" tubes swaged down to 2" at the drums — in all sizes above 15,000 lb per hr capacity. This permits closer spacing of the tube surfaces in the main boiler bank and results in up to 25 per cent more heating surface per tube. It increases mass flow rates, assuring more efficient heat transfer. All this adds to up more steam than from the former VP Boilers of the same size.

All of the existing *extra* features which contributed to the enthusiastic acceptance of the original VP design remain. Briefly summarized they are:

- **More water cooling** per unit of furnace volume than any other boiler of the VP's size and type.
- **Quiet centrifugal fan,** which operates at low speed and with an exceptionally low noise level.
- **Large lower drum,** which facilitates handling wide load swings ... permits a simple, symmetrical tube arrangement ... simplifies inspection.
- **Single Burner** assures balanced furnace conditions and air distribution ... is easier to operate and to maintain ... simple burner control equipment ... no air leakage through idle burner ... change oil gun, when required, in seconds.
- **Simple baffle arrangement,** which means maximum heat transfer rate ... no dead gas pockets ... simplified soot blowing.

The *New* VP Boiler not only looks more attractive but it is functionally improved and stands ready to deliver more steam per dollar.

Write, today, for complete information. Ask for new catalog VP-106 (just off the press) which contains specifications and general information on dimensions, space requirements, construction details and controls. B-812

THE VP BOILER is available in capacities ranging from about 4,000 to 40,000 lbs of steam per hr, and pressures up to 500 psi.

HOW ACCURATELY DO YOU MEASURE

EXCESS AIR

IN YOUR FLUE GAS?

FLUE GAS COMPOSITION

Prevent heat loss up the stack. Too much or too little excess air means big money in today's boiler plant. It's important to *know* and *control* excess air exactly—regardless of load or fuel changes.

Burn multiple fuels efficiently

When switching from one fuel to another or burning more than one fuel at the same time, only an Oxygen Recorder gives you an undistorted picture of excess air. It measures O_2 directly and continuously, without recalibration.

Hundreds of companies are reaping large savings with Hays Electronic type Oxygen Recorders in their boiler plants. Flue gas sampling systems fit a wide variety of installations.

With the Hays Electronic type Oxygen Recorder you get continuous, highly accurate indication and recording . . . complete compensation for temperature and pressure effects . . . freedom from chemicals or hazardous fuel burning in the analyzing process . . . swift, sure electronic operation.

Write today for Hays Bulletin 52-829-56. Also ask for a dramatic comparison graph which shows that the relationship between O_2 and excess air is practically constant for different fuels.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Varriflow Meters and Varitrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY 3, INDIANA

A guide to better flow metering

Here's a new fact-filled, technical booklet that tells you feature for feature how the new Hays electronic flow meter excels.

Electronic operation—provides maximum accuracy (¼% of full scale differential), and speed (4 seconds for full scale pen travel).

Mercuryless transmitters—rupture-proof metallic bellows for differential pressure measurement.

Continuous integration—motor-driven, continuous mechanical integrator is extremely accurate even on rapid load changes.

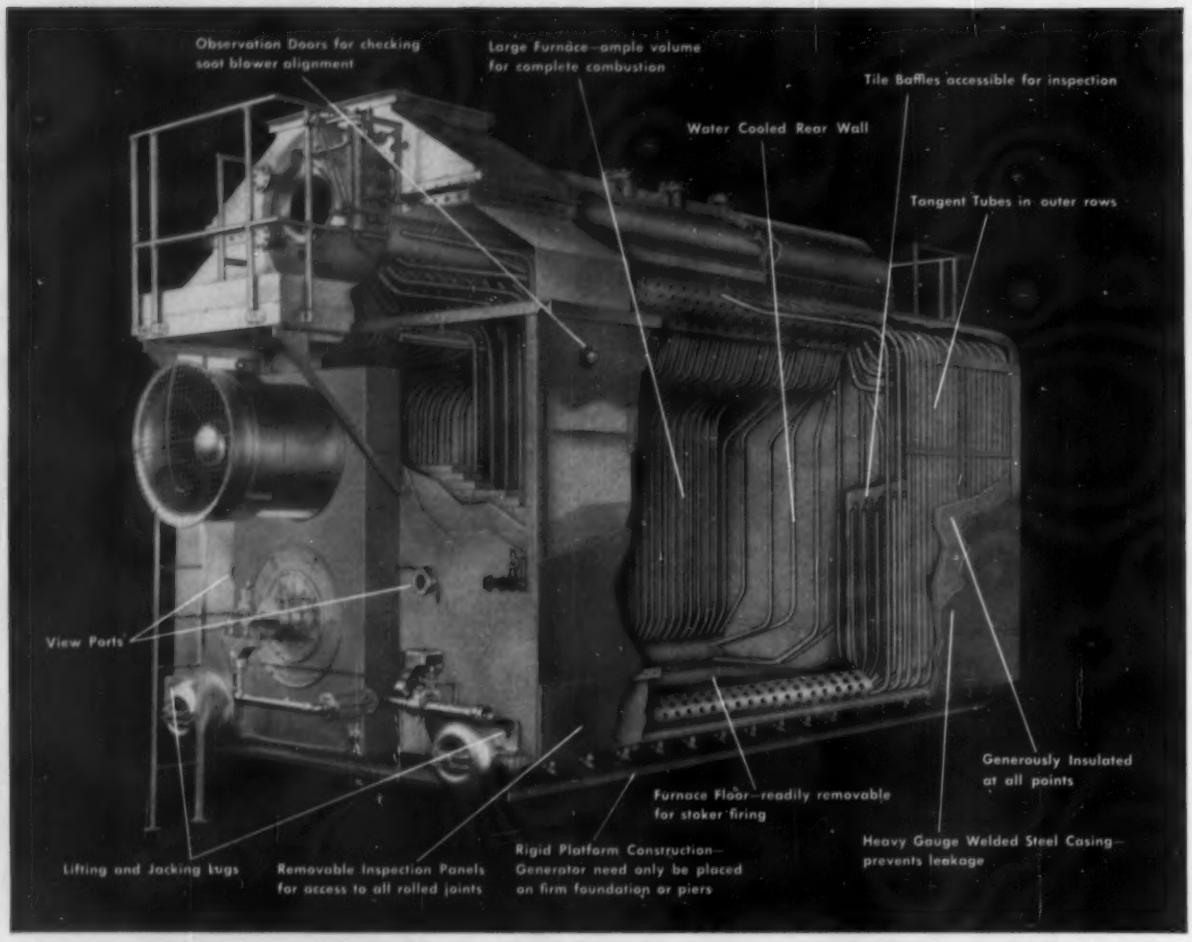
Other features include powerful motor, easy readability, accuracy unaffected by normal temperature changes, optional explosion and weather-proof transmitter.

Write for bulletin 54-1074-222 and get the important facts.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE **hays** CORPORATION

MICHIGAN CITY 3, INDIANA


Observation Doors for checking soot blower alignment
Large Furnace—ample volume for complete combustion
Tile Baffles accessible for inspection
Water Cooled Rear Wall
Tangent Tubes in outer rows
View Ports
Generously Insulated at all points
Furnace Floor—readily removable for stoker firing
Heavy Gauge Welded Steel Casing—prevents leakage
Lifting and Jacking Lugs
Removable Inspection Panels for access to all rolled joints
Rigid Platform Construction—Generator need only be placed on firm foundation or piers

Union Type "MH" Packaged Steam *successfully patterned after job-proved field*

Shop-assembled units handle multitudes of needs formerly requiring costly field erection and special engineering

Erie, Pa. (UIW) — Although packaged water tube boilers are generally a relatively recent development, the Union Type MH Packaged Unit boasts a long record of accomplishment. Its success stems from its compact, balanced, 3-drum design patterned after larger but similar field erected Type H Boilers originated 16 years ago by Union Iron Works, Erie, Pa.

MEETS BROAD RANGE OF STEAM REQUIREMENTS

Delivered by rail or truck, completely shop assembled MH Units can be fitted with components to meet a wide range of steam requirements. Standard units are designed in 13 sizes with capacities ranging from 10,000 to 40,000 lbs. of steam per hour with pressures of 250 psi. Furnished for oil or gas firing, or both, as well as refuse and by-product fuel consumption, MH Steam Generators are equipped with fully automatic, semi-automatic or manual ignition and combustion controls.

HANDLES UNUSUAL AND SPECIAL NEEDS

High pressure units, usually difficult to obtain in a packaged boiler, are nothing unusual for Union Iron Works. Superheaters, of the pendant or drainable type, with or without control, can be installed to meet total temperature requirements. Union heat recovery equipment, both air heaters and economizers, are readily supplied when needed.

The MH Steam Generator is also designed so that it may be easily converted to stoker firing. There are no floor tubes to be removed nor any changes required in pressure parts.

FEATURES SYMMETRICAL, STRUCTURALLY SOUND DESIGN

Many of the prime advantages of Union's Type MH Steam Generator are readily traceable to the unit's 3-drum design which features divided tube banks and tangent tube wall construction.

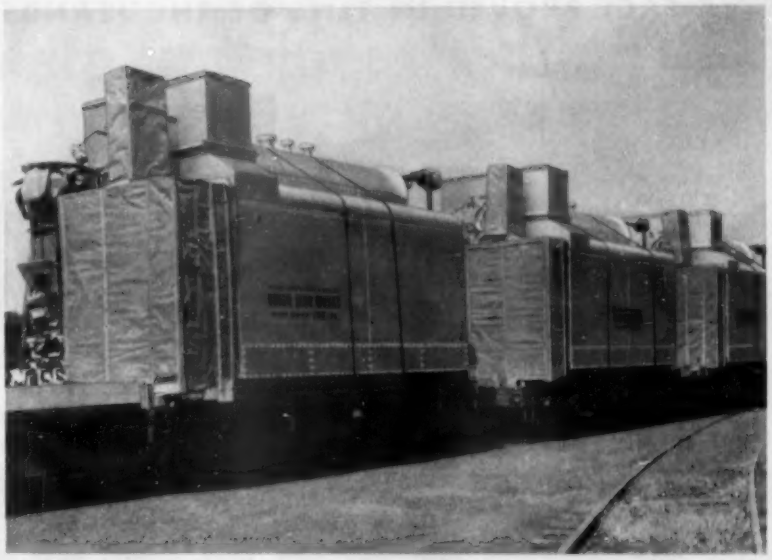
The divided tube banks enclose a self-contained furnace and provide multiple tube rows between the furnace and casing walls. This arrangement and the use of tangent tubes in both outer rows brings about minimum radiation losses and low casing temperatures without heavy refractory wall construction.

HIGH MASS GAS FLOW

The straight through gas flow over the divided tube banks requires furnace baffles only. The tube pattern provides high heat transfer and low exit temperatures without the higher draft losses of a staggered tube arrangement.

RAPID CIRCULATION

There are no long furnace floor tubes, water wall headers nor circulator connections to impede circulation. The MH Steam Generator can be brought on the line quickly and can carry high overloads.

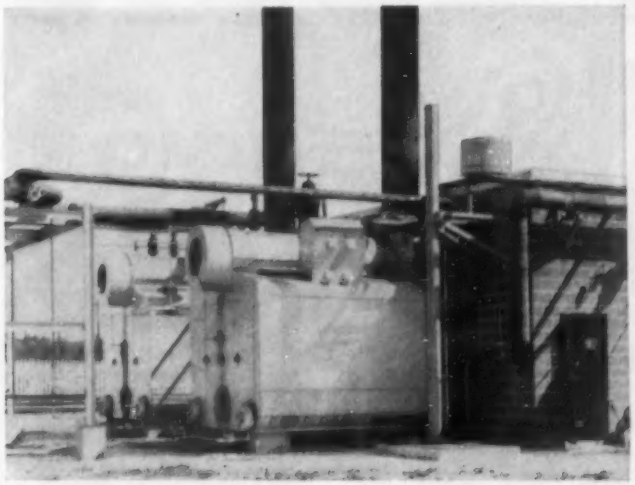


VIA RAIL OR TRUCK — Completely assembled including fuel burning equipment, combustion controls and forced draft fan, Union Type MH Generators are shipped to arrive on-location ready for immediate service.

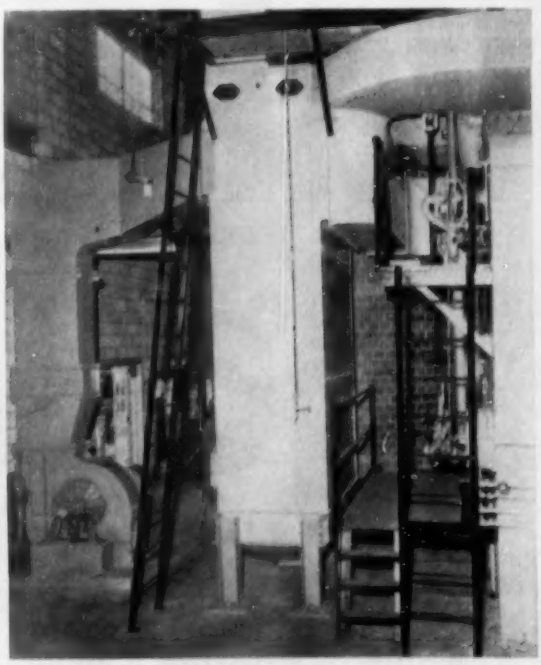
FULLY DESCRIBED IN ILLUSTRATED, 16-PG. BULLETIN

Recently published by Union Iron Works, a colorful bulletin gives a full description of MH Steam Generators and includes: cut-away illustrations, installation photos, tube arrangement layouts, a photo sequence story of shop assembly construction and a dimension table for all standard units. Copies of Bulletin MH 3-54 may be obtained without charge by writing to Union Iron Works, Erie, Pa.

Generators erected designs



ADAPTABILITY PROVED OUTDOORS — Two Union Type MH Packaged Steam Generators serve a chemical processing plant. Each of these gas fired units has a capacity of 18,000 lbs. per hour at 250 psi.



EQUIPPED FOR HEAT RECOVERY — Serving a large printing plant, this oil fired Type MH Packaged Unit is equipped with a forced draft package air heater for 85.79 efficiency.

A FACT PROVED IN TENS OF THOUSANDS OF APPLICATIONS:

when Hancocks go in valve costs go down

MANNING, MAXWELL & MOORE, INC.

WATERTOWN 72, MASSACHUSETTS

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, Stratford, Conn. 'CONSOLIDATED' SAFETY RELIEF VALVES, Tulsa, Okla. AIRCRAFT CONTROL PRODUCTS, Danbury, Conn. and Inglewood, Calif. "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, Muskegon, Mich.

Here's Help in Understanding STEAM-WATER CYCLE ANALYSES

OFTEN, constituents of deposits in steam-water cycles are reported to you in mineral names rather than chemical formulas. To help you better understand reports and analyses with these names, Allis-Chalmers has published a new Informational Bulletin, Number 59. It lists each mineral, then gives the chemical formula, the usual area in which these deposits are found, and the causes and possible preventive measures you can take.

Part of Practical Library

Only careful analysis of all the factors in the cycle can solve a specific water problem. This bulletin will help you understand, generally, the causes and solutions of a variety of water problems. It is one of a series published by Allis-Chalmers. These bulletins reflect Allis-Chalmers wide experience from years of solving water problems in every industry, in addition to solving problems involved in the company's own broad line of power plant equipment.

ALLIS-CHALMERS WATER CONDITIONING
Equipment — Chemicals — Service

Complete Water Conditioning Service

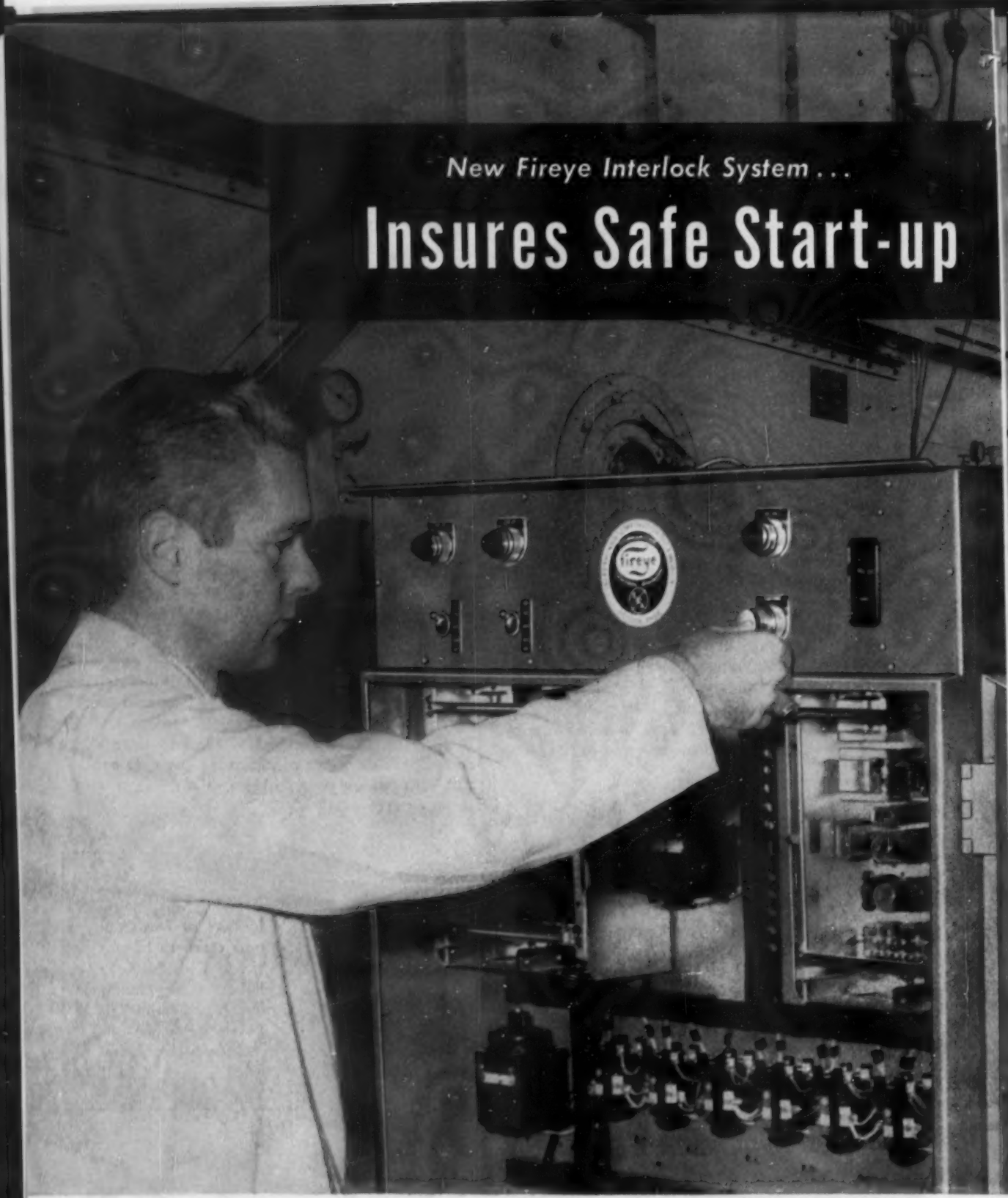
Allis-Chalmers offers complete water conditioning service. You can get analyses and reports on your problems. You can get chemicals needed for water treatment. And you can get the equipment needed for any system.

For your copy of Informational Bulletin 59 explaining the mineral names used in analyses, write Allis-Chalmers, Milwaukee 1, Wisconsin. Or better, call your nearby A-C office to have an Allis-Chalmers water conditioning engineer consult with you on your problem. A-4414

Complete investigative facilities at Allis-Chalmers research laboratories include this X-ray diffraction unit which is used to analyze crystalline structure of deposits from steam-water cycles.

A-C ALLIS-CHALMERS

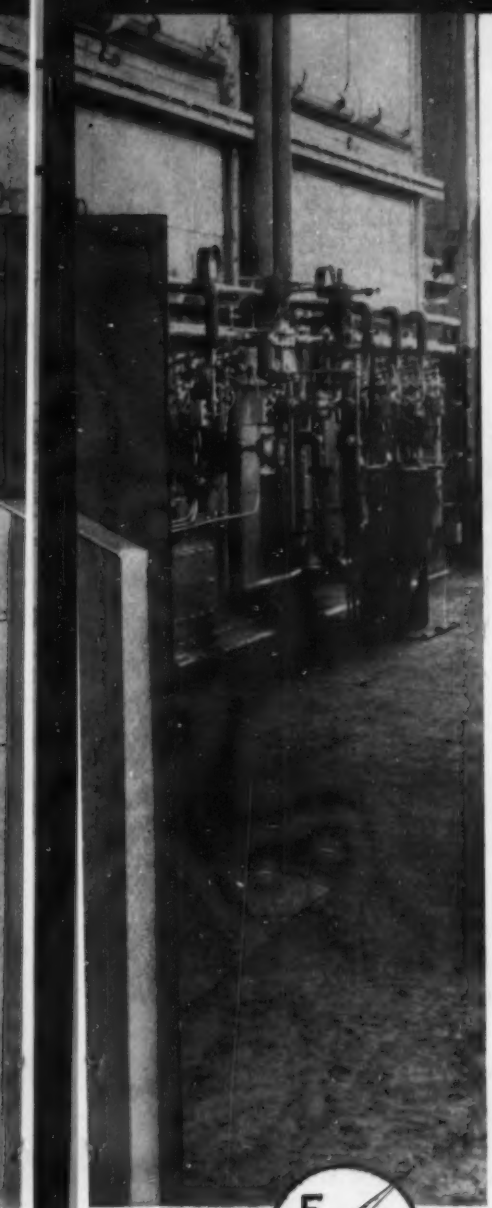
ALLIS-CHALMERS



GET ALL THESE FIREYE ADVANTAGES FOR YOUR BOILER OPERATION

Purging before ignition • Pilot proving • Time limit on trial-for-ignition
Continuous main flame supervision • Instant fuel shutoff and alarm
Easy switching to standby fuel • Insurance acceptance • Proved performance

and Firing of Power Boilers



Here is the most modern, complete protection your boiler plant can have. Developed by the world's foremost authority on *safe fuel burning*, it is the first fully-integrated combustion safeguard system for hand torch or pilot ignited oil or gas burners. It automatically enforces safe light-off procedure and supervises the flame during firing.

Each step of lighting-off each burner is safety-controlled by Fireye's system of timers, interlocks and shutoff valves. In case of flame failure, the system automatically shuts off the fuel within 2 to 4 seconds, and will not permit re-ignition without complete purging of the combustion chamber.

Be sure *you* have this complete protection: This Fireye development includes a pre-wired and tested cabinet assembly of safeguards and controls for any number of burners . . . and all external valves, switches and alarms. It can be installed on any multiple burner furnace. Installation supervision by a qualified Fireye engineer is avaliable. For full information, send the coupon below.

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ELECTRONICS CORPORATION OF AMERICA
718 Beacon St., Boston, Mass.

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E C A fireye

Electronics Corporation of America, Department C9-3
718 Beacon Street, Boston 15, Massachusetts

Please send me your new bulletin describing safe start-up and firing practices for multiple burner boilers.

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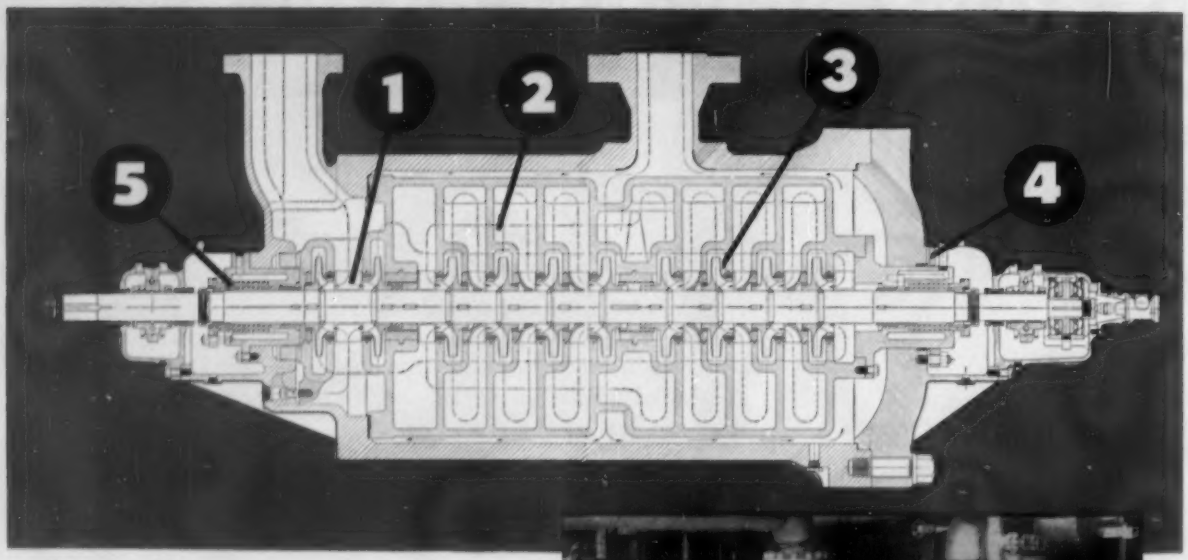
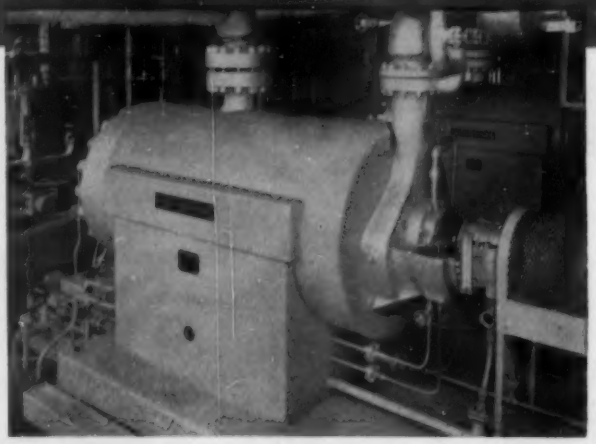
COMPANY _____

STREET _____ CITY _____

Get These 5 Features for Top Boiler Feed Pump Value





1. **Low NPSH** — First stage is two single-suction impellers face to face. NPSH requirement is very low, and interstage leakage is introduced into high pressure side of first stage to prevent flashing.
2. **Double-Volute Casing** — Radial thrust is neutralized regardless of variations in load. Bearings and wearing rings last longer, vibration is minimized.
3. **Back-to-Back Stages** — Arrangement of stages with center discharge maintains axial balance without balancing devices. Thrust from opposed stages cancels out. Any slight unbalance is taken up through a Kingsbury thrust bearing. Great simplicity reduces maintenance.
4. **Easy Casing Expansion Joint Inspection** — The casing expansion joint is brought to the outside where it is easy to adjust and where leakage can be detected and corrected quickly and easily.
5. **Five Sealing Options** — Gland seals may be standard packing, packingless, bleed-off, condensate bleed-in, or mechanical seal, depending on your exact requirements.

ALLIS-CHALMERS BARREL-TYPE BOILER FEED PUMP is the most modern high pressure boiler feed pump available today. Yet every feature has been tested and proved in power plant operation.

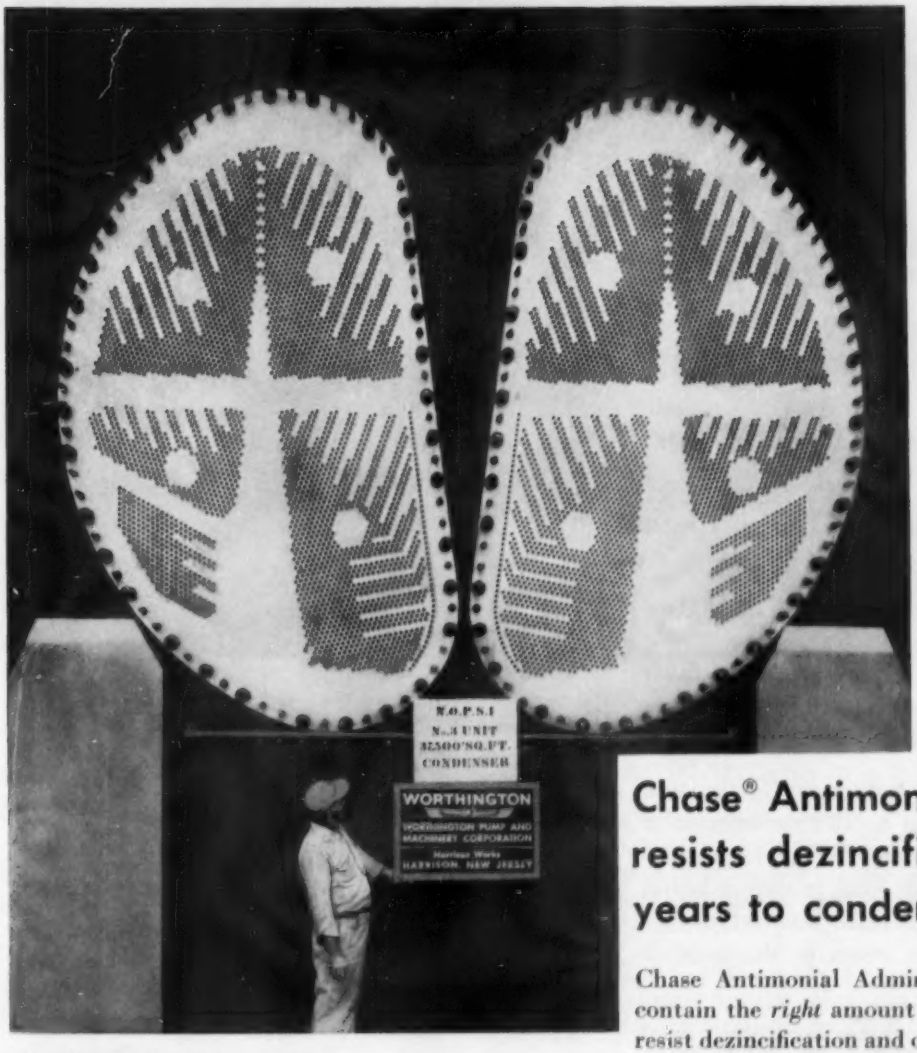
Check this pump point by point . . . check its performance in many power plants across the country. Get full details from your Allis-Chalmers representative or write for Bulletin 08B7899. Allis-Chalmers, Milwaukee 1, Wis.

A-4453

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

RUGGED!



Chase® Antimonial Admiralty resists dezincification—adds years to condenser tube life!

Chase Antimonial Admiralty Condenser Tubes contain the *right* amount of antimony needed to resist dezincification and other forms of corrosion. That's why *Chase* tubes last so much longer!

And antimony will *not* weaken the tube in other ways! That's why *Chase* tubes *stay* sound through years of adverse conditions in the field!

When you replace Condenser Tubes, or plan a new installation, get the benefit of *extra* years of service. Insist on Chase Antimonial Admiralty.

Learn more about corrosion problems, and how Chase can help solve them. Send for free Chase Condenser and Heat Exchanger Tube Booklet.

Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Albany†	Chicago	Detroit	Los Angeles	New York	St. Louis
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Boston	Dallas	Indianapolis	Newark	Providence	Waterbury
Charlotte†	Denver	Kansas City, Mo.	New Orleans	Rochester†	(†sales office only)

Controlling Costs Automatically

Republic Automatic Combustion Controls Offer All Types of Boiler Plants Three Ways to Save

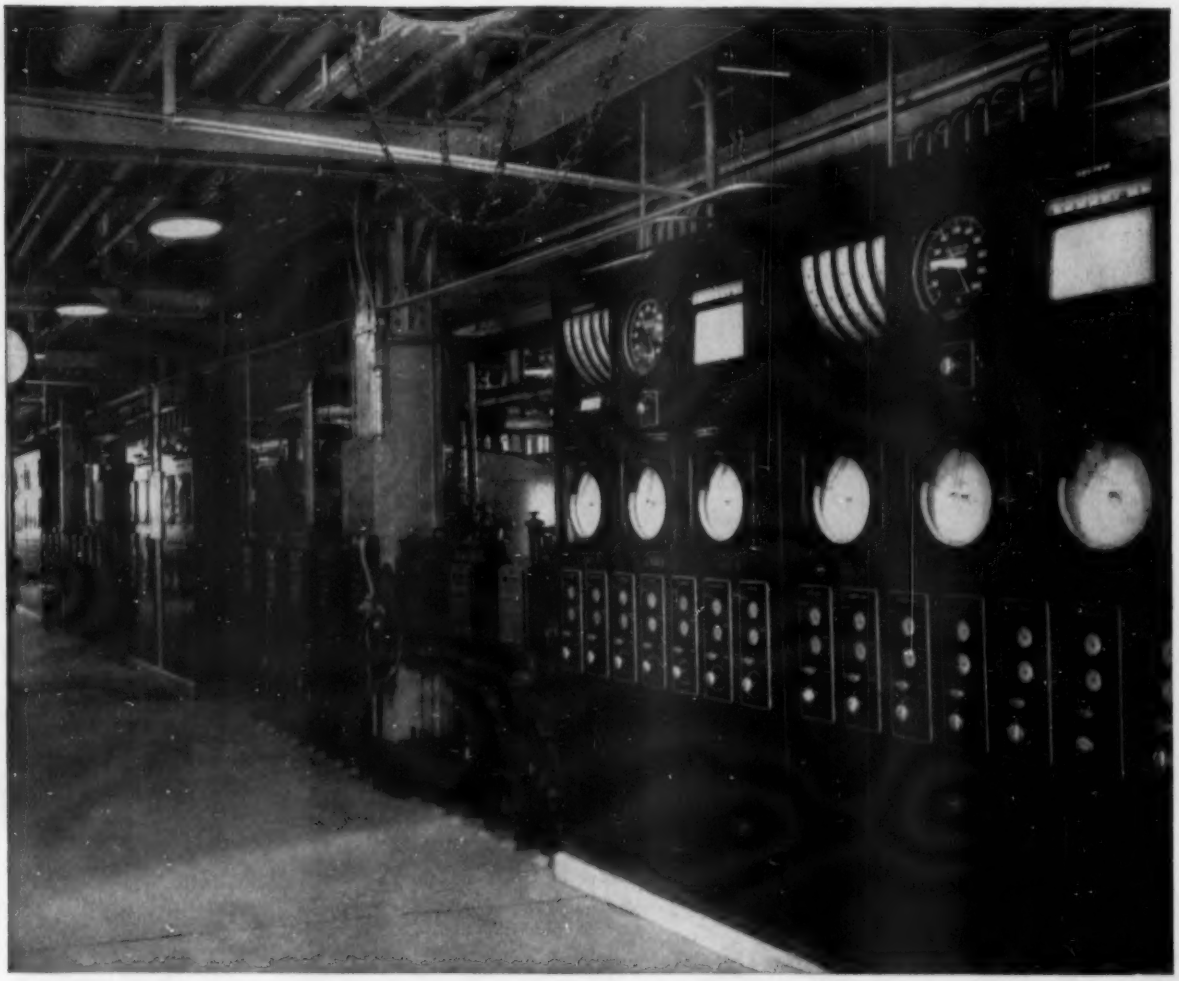
AUTOMATIC combustion controls are looked upon primarily as fuel savers. That's their most important advantage, but their effect on maintenance and equipment costs should not be overlooked, either.

For example, Republic Automatic Combustion Controls hold operating conditions uniform to prevent chain-of-event troubles and high maintenance costs that result from incorrect boiler operation. Republic controls, themselves, are ruggedly built to give years of dependable service.

Also consider the cost of stand-by equipment that must be purchased because boilers can't be continuously operated manually to produce the maximum steam output they are capable of generating. Human efficiency just isn't that good. Boilers operated by Republic Automatic Combustion Controls, however, perform at maximum efficiency, 24 hours a day, 7 days a week . . . at all loads. Expensive excess boiler capacity is not necessary to meet "peak" loads.

Republic Automatic Combustion Controls are used in all sizes and types of boilers, in central stations and in small industrial steam plants. Whatever the size or type of your boiler, the type of fuel burned or the load conditions, we can help you control costs by automatically controlling combustion. Write for complete details or contact your nearby Republic field engineer.

REPUBLIC FLOW METERS CO.



Republic Automatic Combustion Controls

At Carter Oil Company • Billings, Montana

The boiler plant for Carter Oil Company's modern refinery at Billings, Montana is operated for maximum efficiency by a complete Republic control system for combustion, feed-water and desuperheating. Automatic combustion controls are coordinated with feedwater and desuperheater controls to enable the boilers to meet all load changes smoothly.

The plant consists of four boilers, each rated at 42,000 pounds of steam per hour. Total steaming rates average 125,000 pounds per hour. The boilers are gas fired with oil as standby. Both fuels may be fired simultaneously, if desired.

Looking down the firing aisle of the Billings refinery in the photograph above, Republic control panels for the boilers are at right. Located at the left of each panel are Republic regulators which send control impulses to positioners of fuel valves and fans. Feedwater regulators are also located with the combustion regulators.

2240 Diversey Pkwy., Chicago 47, Illinois

POWERFUL GUY!

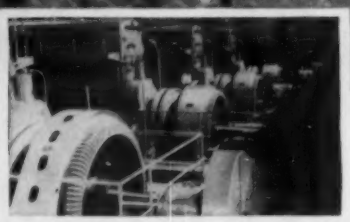
His four Nordberg Diesels, lubricated by Cities Service DC-940 Oil, supply six Oklahoma Counties with REA power. Have one of lowest cost-per-KWH records of entire REA.

His name's H. P. Wingo, and he's Chief Engineer of the REA plant operated by Western Farmers Electric Cooperative.

For the past four years, since his plant began operation in Woodward, Oklahoma, he's been responsible for a consistently high power efficiency rating, measured in cost per kilowatt hour...as high as fifth among all 42 REA plants! To maintain this record, he's had important help... help from four 1100 KW Nordberg dual-fuel engines...and help from Cities Service DC-940 Oil.

"Our engine compressions are the same today as they were after the first three months' operation," says Wingo. "In addition, using Cities Service DC-940, rings have remained absolutely free, liners have worn less than .0015, and we average 14,000 horsepower hours per gallon of oil. Filter elements last up to 1,500 hours."

Wingo has added his words of praise to those of scores of other users of Cities Service Lubricants. Summed up, these reports clearly demonstrate that superior performance is not the exception, but the rule, with Cities Service products. Your Cities Service Lubrication Engineer can readily explain why. Talk it over with him. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

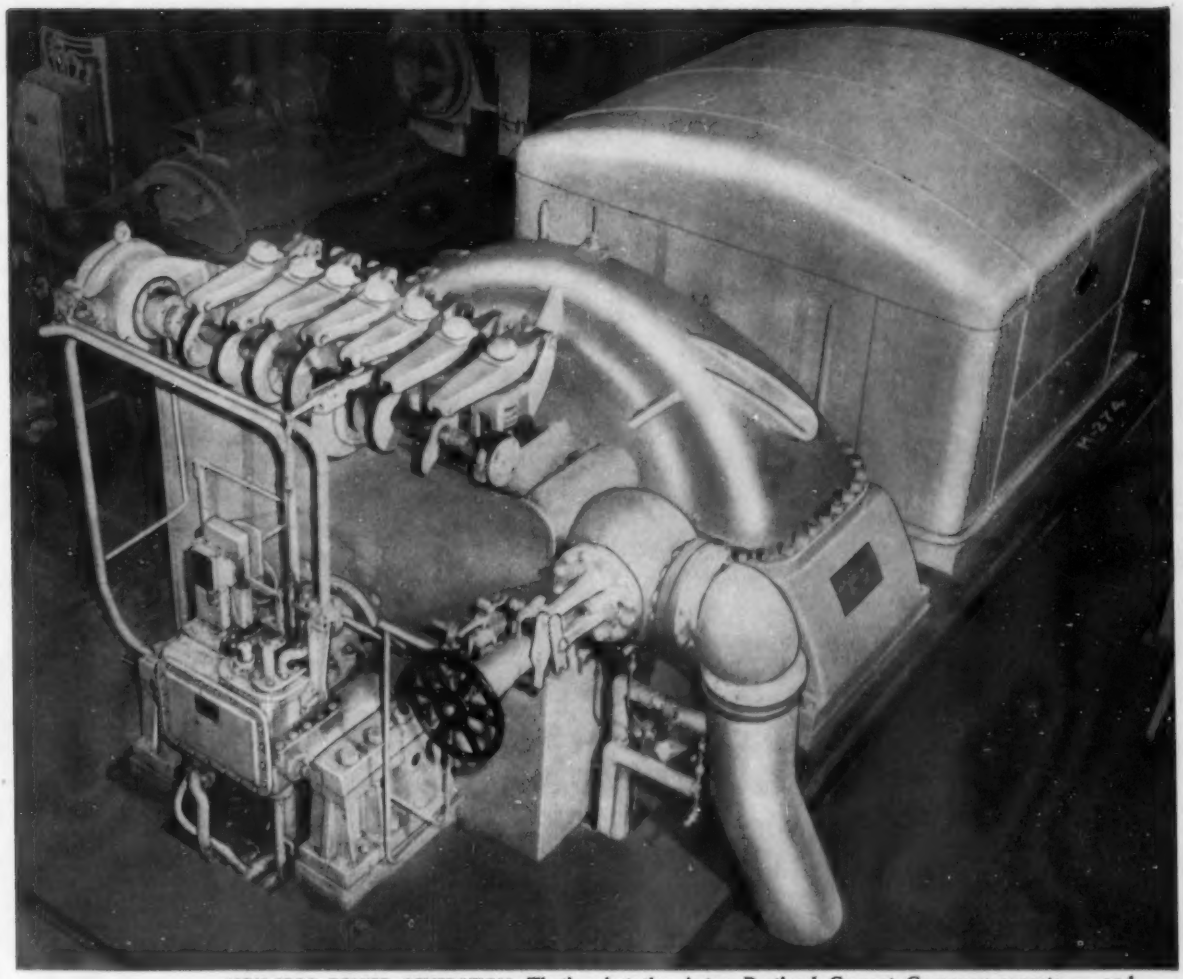


4 NORDBERGS, 4 YEARS OLD ... yet engine compression remains the same as after first three months of operation at Western Electric REA Plant, Woodward, Okla. Rings "absolutely free," liners worn less than .0015, oil consumption at 14,000 H.P. hrs. per gallon using Cities Service DC-940 Oil.

CLOSE CHECK is kept on entire operation. Meanwhile, Cities Service Lubrication checks wear in Nordberg engines, helps engineer Wingo maintain record of low cost electricity. Supplying economical power to six Oklahoma Counties, plant's power efficiency rating has been as high as 5th in entire REA.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS



NON-STOP POWER GENERATION. That's what the Aetna Portland Cement Company expects — and gets — from its 5000-kw Worthington turbine-generator despite the roughest kind of operating conditions.

Runs 52,500 hours without a break

Six years of 24-hour-a-day operation without a stop, except for annual plant shutdown.

That's the record this 5000-kw Worthington turbine-generator has chalked up at the Aetna Portland Cement Company's plant in Bay City, Michigan.

Installed in 1948, the rugged Worthington unit is the main source of power for this cement plant, operating at full load (often at 20% overload) in an atmosphere of highly abrasive dust.

One big reason why Aetna, like so many other leading industrial firms, chose Worthington is the undivided responsibility that goes with every Worthington turbine-generator. Both the Worthington turbine and generator are designed to operate as *one* unit and are assembled and completely tested *before* shipment.

For more facts about Worthington turbine-generators, write to Worthington Corporation, Steam Turbine Division, Section T.4.8, Wellsville, N.Y. T.4.8

"SEE the Worthington Corporation Exhibit in New York City. A lively, informative display of product developments for industry, business and the home. Park Avenue and 41st Street."

WORTHINGTON

STEAM TURBINES

Single- and Multi-Stage Turbines • Turbine-Generators • Deaerators • Boiler Feed Pumps • Surface Condensers

A GREAT TEAM IN STEAM

CUSTOM-BUILT AMERICAN ROLLING RING CRUSHER EXCEEDS RATED CAPACITY BY 32%!

Crushes Up to 80 Carloads (50 Ton Cars) per 7 Hour Day... Reduces Feed Size 8" x 1¼" Washed Coal to 1¼" x 0

This American AC-7-B Crusher was installed with a guaranteed capacity of 440 tons per hour. It has been operating at tonnages up to 584 tons per hour—and maximum output has never been reached, according to the mine's Director of Preparation.

THE REQUIREMENTS WERE:

- High capacity crushing.
- Flexibility in the sizing of the crushed product.
- Consistent sizing for any size feed up to 8"
- Minimum of fines.

Find out how your plant can maintain high production plus full sizing flexibility at low operating costs. Write for American AC Coal Crusher Bulletin.

THE RESULTS:

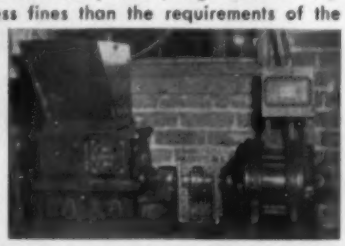
CAPACITY—Reducing 8"x1¼" to 1¼"x0, the American Crusher produced 584 TPH, a 32% increase over guaranteed capacity.

FLEXIBILITY OF SIZING—Whenever a 1" or 1½" product is desired, the sizing can be adjusted externally by means of the Adjustable Drop Cage. Further, the AC-7-B can be adjusted in less than two minutes to produce a 4"x0 product. This flexibility in sizing helps meet the changing market demands of this mine's contracts.

MINIMUM OF FINES—The crushed product, regardless of size being made, contained less fines than the requirements of the mine contracts.

. . . and for low-cost coal sample crushing

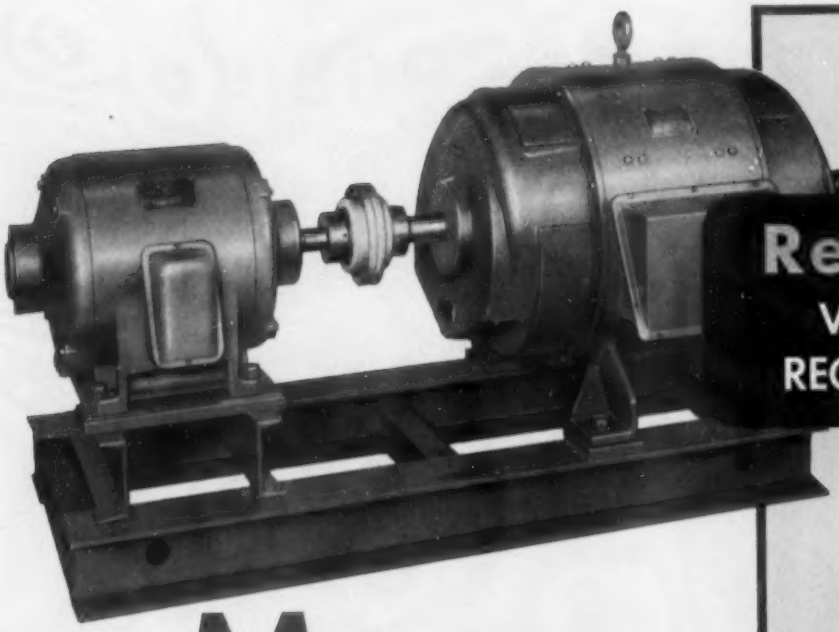
The American Sample Crusher, with the new Adjustable Sampling Hopper, gives you 5% — 10% — 15% or 20% sample of a sample — in one operation.



American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1349 MACKLIND AVE. • SAINT LOUIS 10, MO.



Regulex
VOLTAGE REGULATORS

More Capacity

FROM YOUR PRESENT GENERATORS

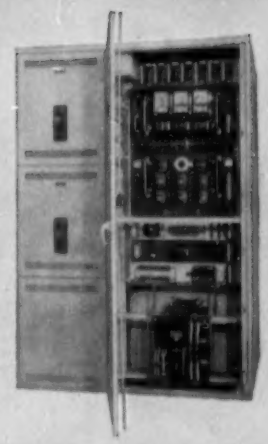
The *Regulex* voltage regulator increases generator capacity by increasing safe operating limits . . . delivering maximum productivity from existing as well as new machines.

How it Works

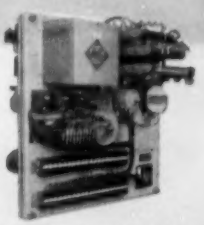
Automatic minimum excitation provided by *Regulex* control permits generator operation close to the stability limit . . . much closer than manual operation permits. Exceptional sensitivity and the rapid response of the *Regulex* regulator and associated equipment establish and maintain a safe ratio between generator load and field current. As a result, operating limits are broadened at any power factor loading . . . proper reactive kva division is assured . . . kilowatt output is increased.

In power plant application, the *Regulex* voltage regulator may be used with alternators or synchronous condensers. No multiple special fields are required in the exciter. Get all the facts. See your A-C representative or write Allis-Chalmers, Milwaukee 1, Wis.

Regulex is an Allis-Chalmers trademark.



The *Regulex* regulator consists of two parts: (1) a motor-generator set . . . (2) a cubicle containing static regulator elements.



New

Magnetic Amplifiers

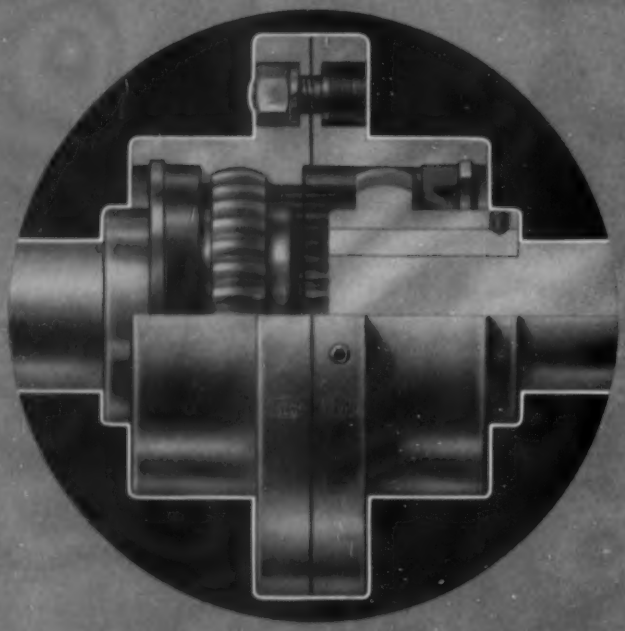
These components *supplement* the *Regulex* rotating amplifier in most applications. The magnetic amplifier is used primarily where reversible output from the amplifier is not required. Special exciter design is eliminated in such applications.

A-4584

ALLIS-CHALMERS

A BETTER GEAR COUPLING

...with teeth cut on a true ARC



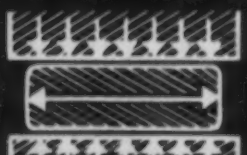
SPHEREFLEX

- UP TO 7° ANGULAR MISALIGNMENT
- FULL FACE TOOTH CONTACT ALWAYS
- CONSTANT ANGULAR VELOCITY

NOT THIS

Standard gear type coupling—note excessive backlash and stress concentration when coupling is flexed.

THIS



"SPHEREFLEX" . . . teeth do not depend on backlash—teeth mesh snugly together, tolerances are reduced to absolute minimum.

The new and different "SPHEREFLEX" Coupling has been exhaustively tested in a wide variety of severe applications—and in every instance has proved itself a superior coupling. "SPHEREFLEX" Couplings are now available from stock at competitive price levels with conventional couplings.

The "SPHEREFLEX" is different and better, because the male teeth are cut on a "true spherical arc", while the internal teeth are cut with a straight root—permitting the curved tooth to always maintain a full line of contact with internal tooth even when the coupling is flexed. . . . Also this feature eliminates the usual dependency for flexibility upon excessive backlash between coupling teeth, point contact or springs. . . . In fact, size for size, the "SPHEREFLEX" Coupling will withstand higher horsepower and greater misalignment than any other comparable coupling. Standard "SPHEREFLEX" Couplings will compensate for angular misalignment up to 3½° plus or minus on each coupling half, or a total of 7°. Special "SPHEREFLEX" Couplings are available for 14° misalignment. Write for new Catalog C-540.

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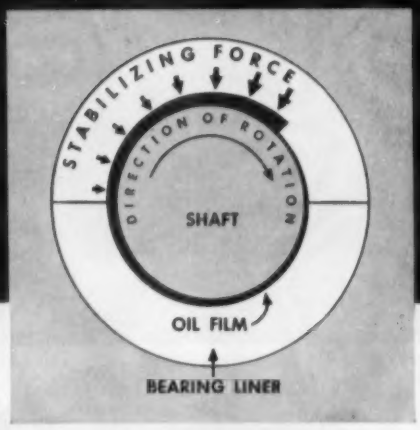
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.
Virginia Gear & Machine Corp., Lynchburg, Va.

Industrial Gears & Speed Reducers

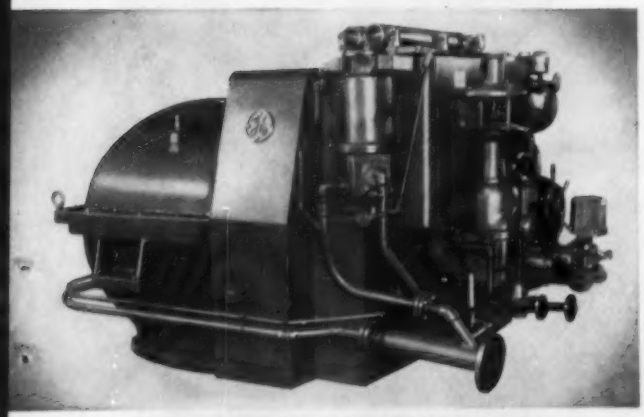
LimiTorque Valve Controls

established 1892



OIL DAM IN UPPER BEARING HALF, located at pencil point, restricts oil flow around shaft, building up a pressure pad as shown at left. As turbine gains speed, oil pressure increases and forces shaft down into ample surfaces of lower bearing liner, above right, assuring stability at high speed.

Large pressure-pad bearings add years of life to G-E high-speed turbines



TYPE DRV HIGH-SPEED MECHANICAL-DRIVE TURBINE

To provide longer, more reliable service, all G-E high-speed turbines incorporate large pressure-pad bearings. The generous surfaces of the bearings assure low unit loading for ample lubrication and minimum wear during start-up.

As turbine speed increases, the viscous pump action of the shaft carries oil into the cavity, building up a pressure pad. This forces the shaft down into the lower bearing half, thus minimizing the possibility of vibration, with its detrimental effect on bearing and packing life.

This is only one of many design features that make a G-E high-speed turbine your most reliable drive for compressors and blowers. For more information contact your nearest G-E Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y. In Canada, contact Canadian General Electric Company, Limited, Toronto. 241-1

Progress Is Our Most Important Product

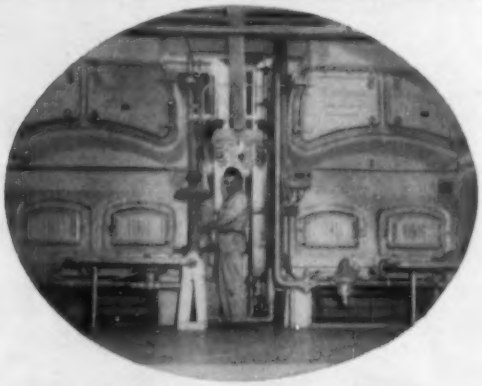
GENERAL ELECTRIC

HOW "RESERVE STEAM" HELPS MRS. BAIRD'S BREAD CO. KEEP PACE WITH GROWING MARKETS

KEWANEE reserve plus rated

. . . BOILERS PROVIDE FOR FLUCTUATING LOADS AND FUTURE EXPANSION

It's "full steam ahead" for growth at Mrs. Baird's Bread Co., Dallas, Texas. That's because management looked well into the future in planning the company's modern plant. Take the boilers as an example. Past experience proved that boilers with reserve capacity could economically provide sufficient power to meet the needs of expansion. Kewanee Reserve Plus Rated Boilers were installed, with 50% extra power built in for additional capacity requirements. When fluctuating loads demand more steam at once . . . it's there with Kewanee. When expansion calls for more steam . . . it's there with Kewanee. So, when you consider boilers, don't be misled by promises that a boiler delivers enough steam to meet average daily requirements. Look for reserve to assure performance beyond the call of usual duty. Consider Kewanee Boilers, rated on nominal capacity to operate at "cruising speed". You'll get greater efficiency at lower cost, plus longer boiler life. Only a boiler rated on nominal capacity can make that guarantee.



Here are 2 Kewanee No. 5188 Boilers installed at Mrs. Baird's Bread Co.

KEWANEE BOILERS

KEWANEE-ROSS CORPORATION, Kewanee, Illinois

Division of American Radiator & Standard Sanitary Corporation

Serving home and industry: American-Standard · American Blower · Church Seats & Wash Fixtures · Detroit Controls · Kewanee Boilers · Ross Exchangers · Tuttle & Bailey Air Conditioners

YOU can depend on KEWANEE engineering

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

POWELL STEEL VALVES

FIG. 11323—1500-Pound Motor Operated Steel Pressure Seal Gate Valve

FIG. 3003 WE—Steel Gate Valve For 300 Pounds W.S.P.

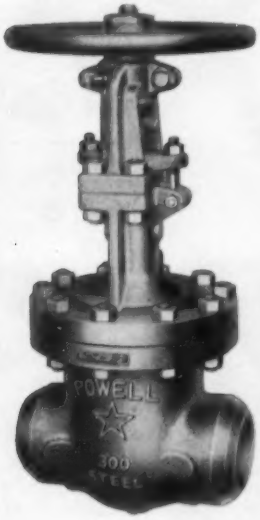


FIG. 11365—Steel Pressure Seal Horizontal Lift Check Valve For 1500 Pounds W.S.P.

FIG. 1314-A—1500-Pound Integral Bonnet Steel "Y" Valve

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

Wherever flow requires dependable control, there's the place for Powell Valves. Powell can supply just the valve you need, for Powell probably makes more kinds of valves and has solved more valve problems than any other organization in the world.

Shown above are just a few Powell Steel Valves. Investigate their many outstanding features . . . *and the complete line* of quality valves famous for dependable service.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have. Write . . .

The Wm. Powell Company, Cincinnati 22, Ohio . . . . . 109th year

Garlock 150
High Pressure
Steam Packing

Garlock 234
ROTOPAC Rotary
Pump Packing

Garlock 117
Valve Stem
Packing

Garlock 777
Low Pressure
Packing

Garlock 262
Special Hydraulic
Packing

Garlock 730
LATTICE BRAID*
Asbestos Packing

Garlock 430
CHEVRON*
Hydraulic Packing

Garlock 900
Compressed Asbestos
Sheet Packing

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Look for the familiar Garlock trademark. It is your guarantee of dependable, proven, high-quality products. AND—your Garlock representative is a packing specialist, selling only Garlock products. Call him in for all your packing requirements.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

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In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

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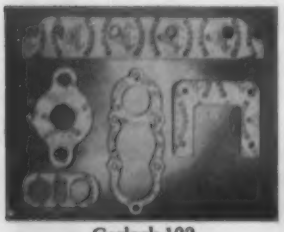
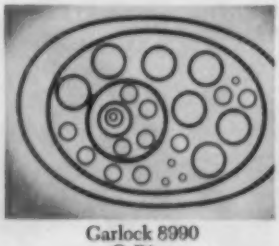
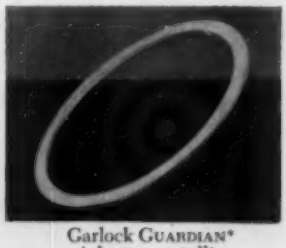


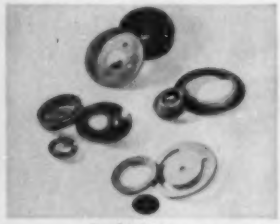
Garlock 122
Red Rubber
Gaskets



Garlock 8990
O-Ring
Packings



Garlock GUARDIAN*
Asbestos-metallic
Gasket



Garlock BITAN*
Leather Cups, Packings
and Gaskets

Garlock "Teflon"
Packings and
Gaskets

Garlock 631
Twisted Lead
Foil Packing

Garlock MECHANIPAK
Package Seal for
Rotary Shafts

Garlock 875
Floating Metal
Packing

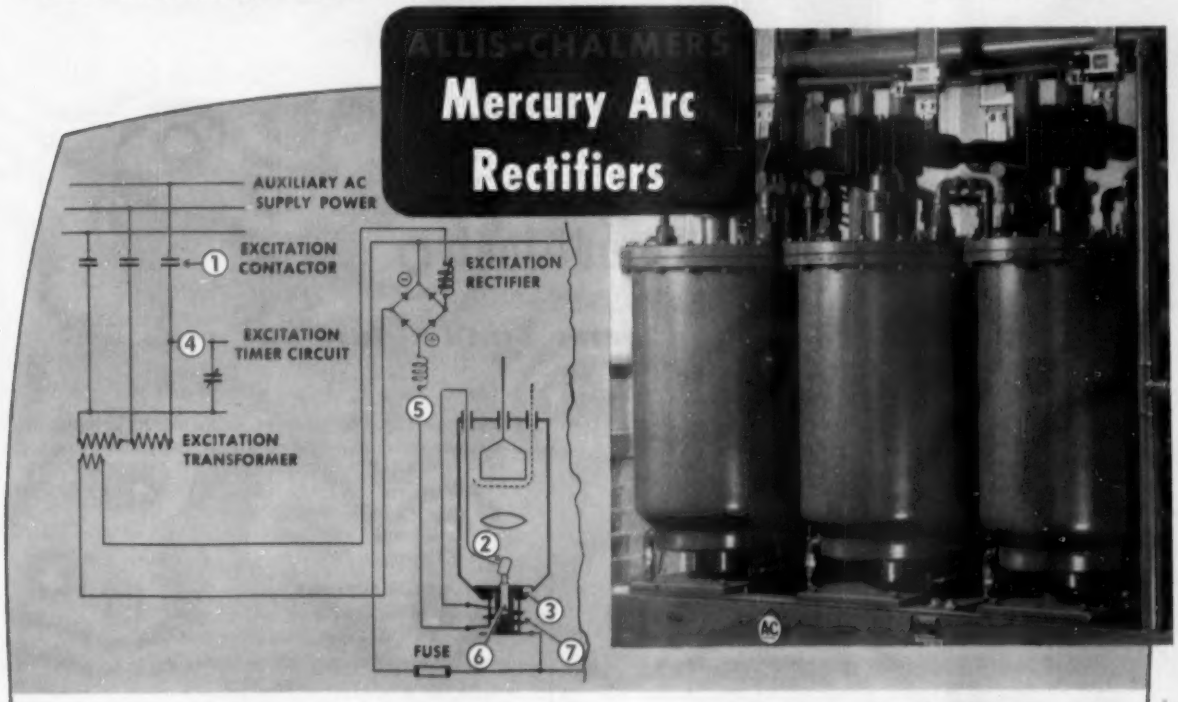
For Reliable Rectifier Operation Get

Continuous Excitation

Allis-Chalmers excitron rectifiers eliminate the need for a pulse-type firing system timed for operation every cycle. Maintenance is easy because of the simplicity of design.

A small dc excitation arc is automatically ignited only once, when the unit is started, and then maintained on the mercury cathode of each rectifier tube. It offers advantages similar to a pilot light. Since it is far easier to maintain an arc than to start it, this feature makes the excitron far less likely to lose excitation during power supply disturbances than other types of rectifiers.

Get all the facts about excitron rectifiers before your next installation. Call the A-C office nearest you or write Allis-Chalmers, Milwaukee 1, Wisconsin.



Supply of DC Provides Key to Continuous Excitation

Direct current supplied from excitation rectifiers is the key to continuous excitation. When the excitation system is energized by means of a contactor (1), positive dc potential appears on the excitation anode (2) of each tube, negative at the cathode (3). A timer (4), through contacts of the excitation failure relay (5), is energized at the same time.

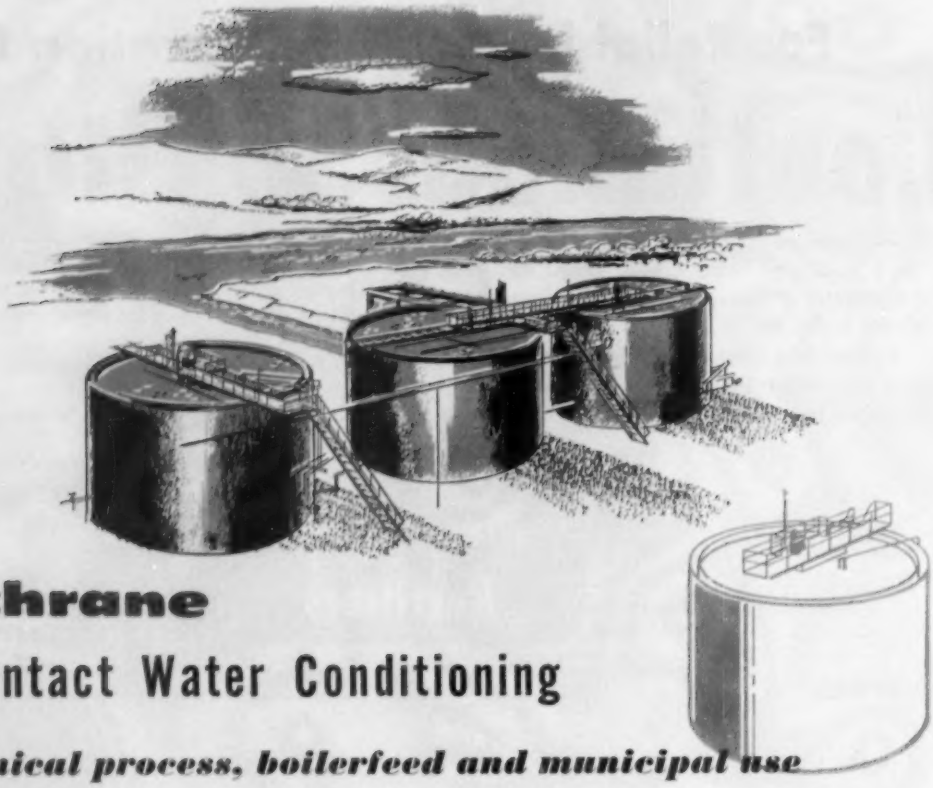
As soon as voltage is applied, current flows from the anode to the cathode through the ignition plunger (6). This current energizes the ignition coil (7) and causes the plunger to be pulled below the mercury surface. As the plunger travels down, an arc is drawn which transfers from the graphite tip of the plunger to the mercury. This current flow keeps the coil energized, maintaining a continuous arc.

If excitation failure should occur while the rectifier is carrying load, the plunger is released, floating upward in the mercury until it makes contact with the anode, then repeating the process above until the arc is re-established.

Re-establishment of the arc as outlined takes less than a second — it does not interfere with normal operation.

ALLIS-CHALMERS

A-4592



Cochrane

Solids-Contact Water Conditioning

for economical process, boilerfeed and municipal use

Here's a Reactor—for either cold process coagulation or lime softening—that covers the 8 basic requirements of suspended solids contact reactor design:

1. Combines two-zone (reaction and clarification) with baffles between them in one package unit.
2. Uniformity of influent distribution and effluent collection.
3. Immediate contact of new precipitates with old.
4. Variable speed agitator design to assure optimum speed selection.
5. High slurry strength in reaction zone for complete reactions.
6. Separation of water from suspended slurry in a minimum of space.
7. Very large Sludge Concentrator to reduce desludging waste water to a minimum.
8. Automatic desludging for saving of time and labor of attention.

Cochrane Solids-Contact Reactors are only one of the many methods of water conditioning Cochrane provides for industry and municipal use. Cochrane manufactures every type of precipitation and ion exchange water conditioning equipment which assures you of unbiased recommendations for equipment to meet your requirements. Its complete service provides single responsibility for engineering, fabrication and continued satisfactory operation.

For information on Cochrane Solids-Contact Reactors, write for Publication 5001-A

Other Cochrane Processes

HOT ZEOLITE SOFTENER

Supplements hot lime process softener. High temperature ion exchange resins completely remove residual hardness at great savings in soda ash and phosphate. Publication No. 4801.

DEMINERALIZER

Cochrane ion exchange units deliver a continuous supply of demineralized silica-free water at extremely low cost. Publication No. 5800.

JET TRAY DEAERATOR

Delivers deaerated water with an oxygen content not to exceed 0.005 cc. per litre—less than 7 parts per billion! Publication No. 3305 and 4643.

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Cochrane
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Representatives in 30 principal cities in U. S.; Toronto, Canada; Mexico City, Mexico; Paris, France; Havana, Cuba; Caracas, Venezuela; San Juan, Puerto Rico; Honolulu, Hawaii.

Pottstown Metal Products Division—Custom built carbon steel and alloy products

Demineralizers • Hot Process Softeners • Hot Zeolite Softeners • Dealkalizers • Reactors • Deaerators • Continuous Blow-Off • C-S Systems • Specialties

ASME celebrates

BACK ON THAT FEBRUARY DAY in 1880, things were not going too well at the meeting in the editorial offices of *American Machinist*. Some 30 of the nation's leading mechanical engineers had gathered there to discuss plans for a new technical society. Now they were on the verge of disagreement.

Into the breach stepped Horace B Miller, publisher of *American Machinist*. His tactful invitation to dinner at the old Astor House—and his fine choice of wines—turned the evening into a memorable occasion. At a second meeting, held at Stevens Institute of Technology, the American Society of Mechanical Engineers was formally organized.

This little story of the beginnings of a great engineering society has always interested me—not only for the human light it casts on our engineering ancestors, but primarily because it all started in an editorial office. To me, it seems natural that it should. A stated purpose of the proposed society was "collection and diffusion of definite and much needed information." Such a statement could equally well sum up the aims of a good technical magazine, indicating a real and significant mutality of interest.

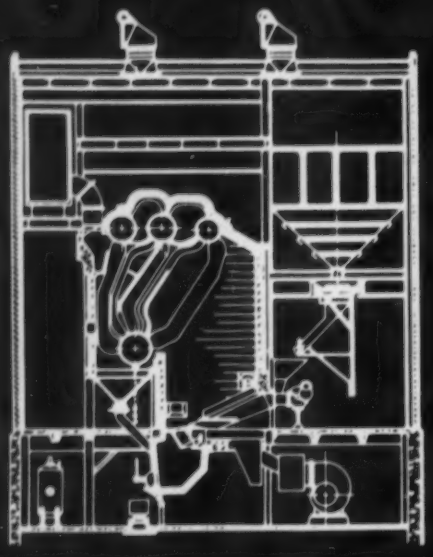
Seventy-five years later, this significance still stands out clearly. It was reaffirmed in the theme of ASME's first Diamond Jubilee meeting, which opened at the McGraw-Hill Building on the morning of Feb 16. Commemorating ASME's beginnings in the editorial offices of *American Machinist*, the theme was "The Engineer in the World of Communications."

Today, such a theme has many aspects. But still central is the constant interchange of ideas and experience *among engineers* that is the very basis of technological progress. In this flow of information, the engineering societies and technical publications occupy key positions as stimulators of thought and transmitters of knowledge.

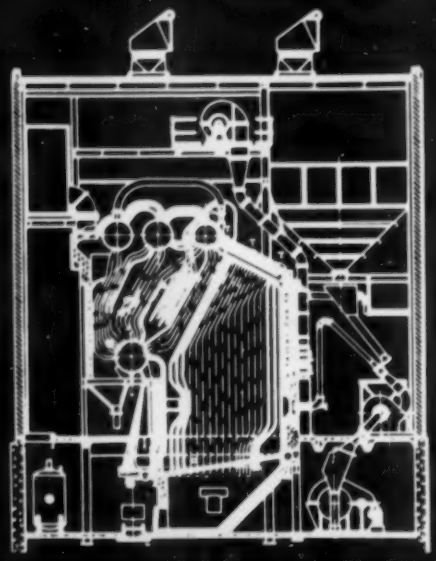
This common responsibility in the field of engineering communications is one reason ASME's 75th anniversary is close to the hearts of all of us on POWER. Another lies in a long history of personal participation in the work of ASME—over more than 70 years, POWER editors have found abiding satisfaction in forwarding its aims and activities. Chief among them, of course, was the late Fred Low, who contributed so materially to two major ASME programs—the Boiler Code and the Power Test Codes. In 1924, he was honored by election to the society's presidency.

So it is that our congratulations to ASME on 75 years of service to the engineering profession carry the special warmth of shared responsibilities and personal associations. And we have particular reason for joining all engineers in the firm belief that the American Society of Mechanical Engineers will continue to grow in stature and leadership.

ARE COAL COSTS DIGGING



BEFORE: Using premium coal on stokers



AFTER: Using low price coal through pulverizers

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COAL PULVERIZED TO SUPERFINENESS

COAL COMPLETELY CARBURETED READY FOR COMBUSTION

BIG TRUNNIONS FOR AIR SWEEPING

BALLS ADDED WITHOUT SHUTTING DOWN

LOW OPERATING AND MAINTENANCE COSTS

UNBURNT CARBON LOSSES LESS THAN ½%

INSTANT RESPONSE TO CONTROLS

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PULVERIZE ANY COAL
BITUMINOUS
ANTHRACITE
COKE BREEZE

TRAMP IRON ACTUALLY AIDS IN PULVERIZING

RESERVES OF FUEL FOR INSTANT RESPONSE TO STEAM DEMAND

IT COSTS LESS TO OWN THE BEST!

Are you profiting from All these advantages?

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simple arithmetic proves you can save

UP TO $3.00 PER TON

with Kennedy pulverized coal firing systems!

If you are planning to modernize your plant or build a new one . . . or *if you are just interested in cutting fuel* costs . . . let us show you how the KVS Pulverized Coal Firing System saves up to $3.00 per ton by preparing and burning low grade coal the Kennedy way.

By using low priced coal, *pulverized to superfineness by the KVS system,* you obtain maximum heat. Higher priced coal cannot produce any more BTU's and you effect tremendous savings in tonnage costs through the use of properly prepared, low cost coal.

Whether you convert from stokers to KVS pulverized coal firing with air swept tube mills or install an all-new plant, the savings you can effect will more than offset the cost plus the fact that steam capacity is increased and maintenance costs decreased.

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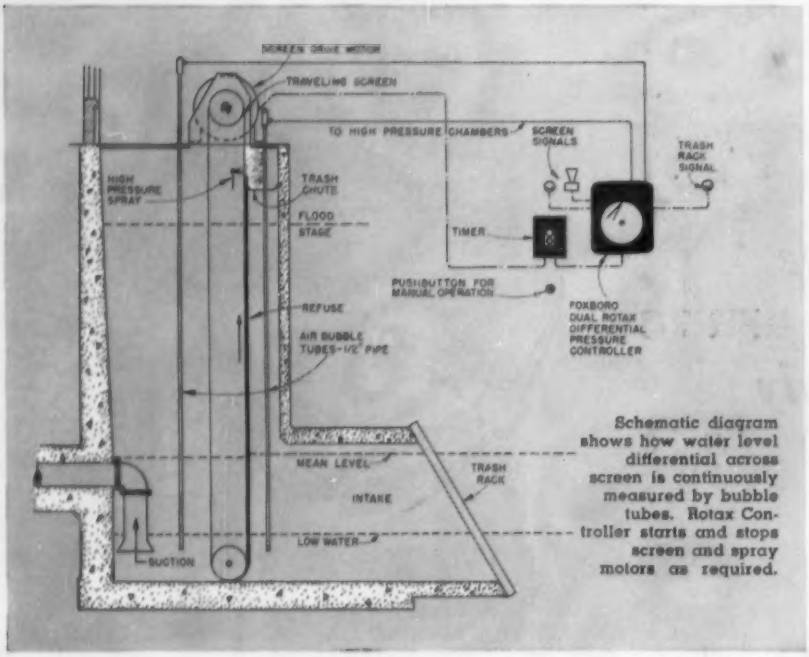


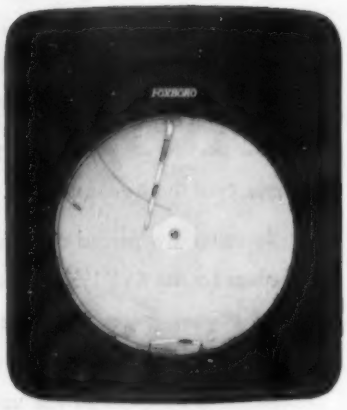
Schematic diagram shows how water level differential across screen is continuously measured by bubble tubes. Rotax Controller starts and stops screen and spray motors as required.

. . . with Foxboro liquid level type screen control

Make sure your intake suction well can't go dry when excessive refuse suddenly piles up on the traveling intake screen!

The Foxboro Traveling Screen Control System automatically starts the screen-rotating motor and the cleansing spray whenever refuse accumulation causes the water level difference between opposite sides of the screen to exceed a certain preset value. Quickly, it purges the screen of refuse and restores the intake level to normal — or sounds an alarm indicating that the cleaning mechanism is unable to cope with the difficulty. What's more, this action takes place only when the screen actually becomes clogged . . . no waste of power or unnecessary wear on mechanism through needless periodic operation.

The Foxboro Traveling Screen Control System is easy to install, inexpensive to operate, and pays big dividends in better intake operation, less maintenance and greater peace of mind. Write for complete information. **The Foxboro Company, 683 Neponset Ave., Foxboro, Mass., U.S.A.**



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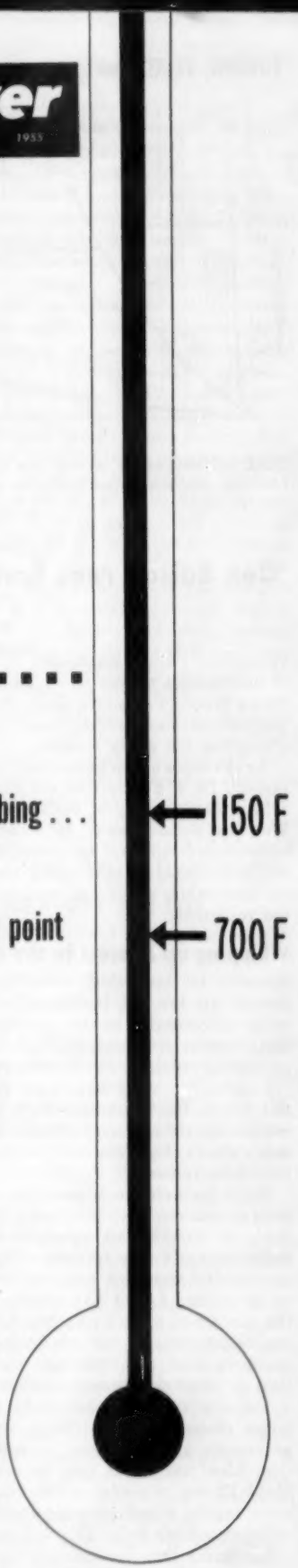
Power
MARCH 1955

Fire-resistant turbine fluids bow in.....

as throttle temperatures keep climbing . . .

way beyond lube oil's self-ignition point

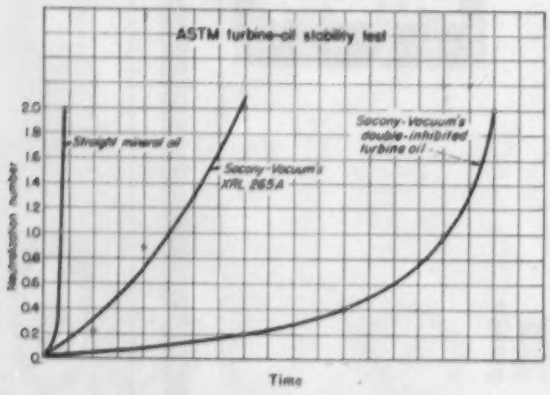


Several utilities are nudging the start line to get first crack at a fire-resistant lube in turbine-generator . . . but there are problems

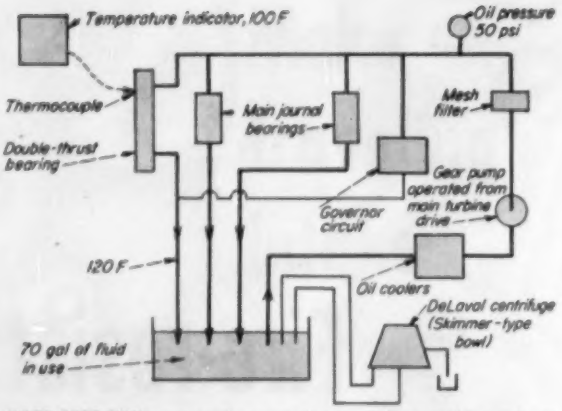
- **One big question: How to protect generator windings from fluid's harmful effects?**
- **Promising fluids are similar to synthetics widely used in aircraft, industrial hydraulics**
- **Both oil companies and chemical concerns are shaping up as potential suppliers of new lubes**
- **Con Edison in N.Y.C. has been running straight synthetic as bearing lube in turbine-pump**

By J J O'CONNOR
Associate Editor

Now turn page



REAL SIGNIFICANCE of this test is yet undetermined: Neut No. rise may not be as indicative with synthetics as with oil



FIRST TEST RUN was made in small Con Edison turbine, above, using Socony-Vacuum's *XRL 265A* phosphate ester base fluid

'Con Edison runs first field test . . . and early results look good'

In tackling a study penetrating into the current practicality of fire-resistant turbine fluids, the Edison Electric Institute's Prime Movers Committee some three years back teed off a program that has fruitfully fanned a long-smoldering interest throughout the utility industry.

As chairman of the Committee's segment spearheading the project, Dr S F Whirl of the Duquesne Light Co led off with a close scrutiny of the literature and patent situation. With that squared away, he drafted a letter to the turbine builders and lubricant suppliers. His aim: Awaken interest in the old problem of ferreting out a lubricating fluid with the plus values of oil, but possessed of a greater degree of fire resistance.

Whipping up interest in the new lubes

Reaction to the kickoff letter was mixed. Where fertile ground was reached, positive steps were taken that led directly or indirectly to the position the industry now occupies: Several promising fluids are on tap, but each has its own set of problems awaiting answers in operating turbines.

Utilities for years have been running hot and cold on this fire-resistant question. Each time in the past it has popped up, the necessary decision in the absence of suitable fluids was to emphasize costly design precautions in the turbine lube system.

But today's picture is taking on a get-things-done hue for several reasons: (1) successful background of synthetic fluids in aircraft and industrial hydraulics (2) potential dollar-savings that may come about through easing of the present fire protection required in central stations because of the oil-fire hazard (3) climbing steam temperatures at the throttle of today's turbines. Right now the utility companies are pressing for a solution. Result is the lubricant suppliers, both petroleum and synthetic, have taken more than an academic interest in finding a suitable fluid.

The now well-established boiler-turbine unit design, with larger chunks of capital being invested in single turbine-generators, places a higher premium on down-time prevention. Also, with steam temperatures to turbines increasing about 12 deg annually, the higher temperatures of today's units supply added impetus toward pinning down a fire-resistant turbine fluid. This is brought more into focus by remembering that the spontaneous ignition temperature of present-day petroleum lubricating oil is about 700-900 F.

Today, we're entering the 1200-F range with a planned 275,000-kw Westinghouse unit slated for Philadelphia Electric. Large-oil-system capacities, which go hand in hand with bigger units, increase the potential seriousness of any fire simply because there's more oil to burn.

How serious is the oil fire hazard in today's steam turbines? That's hard to say. But after thumbing through many fire reports tucked away in insurance company files, you are left with the feeling that fires in central stations are far fewer numerically than current interest might indicate. Nevertheless, the industry has taken the healthy positive approach of ferreting out a suitable fluid if at all possible. Case studies of past fires indicate, as would be expected, the majority of oil fires are preceded by a mechanical break in the lube system, permitting oil to spray or cascade onto the hot steam lines.

The term 'nonflammable' can be misleading and should be avoided since essentially all organic liquids can be made to burn under some conditions. For this reason the term "fire-resistant" is fast being adopted in current discussions.

Hydraulic fluids prove springboard

In the early days of steam turbines, builders had little concern with fire protection. Steam temperatures were low and control systems simple. Lube piping from bearing pedestals ran above the operating-floor level, while steam chests and servomotors were mounted on machine-floor level or on turbine casing. Oil reservoirs, spotted directly in front of turbines, were just low enough below the operating-floor level to provide slope for oil return.

Turbine-lube designs have progressed from that point to where today little of the piping is above operating-floor level. Oil reservoir is remote from the turbine, possibly in a fireproofed room at basement level. We may see a major simplification in lube-system design with the advent of fire-resistant fluids.

Right now several fire-resistant fluids appear promising. A few have been bench-tested and, as is believed in some quarters, are ready for full-scale testing in an operating turbine.

Today's fluids in the fire-resistant category, slated for eventual use in steam turbines, lean heavily for their technical

support on the background work done in industrial and aircraft hydraulics. There the fire problem was wrestled with for years and several materials have evolved that are doing a topnotch job.

Perhaps the most concise recent review of current materials, successfully used as fire-resistant fluids in industrial hydraulics, was made during the annual meeting of the American Die Casting Institute in Chicago, Sept 1954. Although the materials reviewed at this meeting were specifically designed for industrial hydraulic applications, they have a makeup that is similar to the synthetic fluids now being investigated for steam turbines. The approach to fire resistance in the nonturbine field has been mainly through the use of synthetic fluids.

A close look at the synthetics

The chemical people split synthetic fluids into *water-base* and *nonwater-base* materials. As pointed out by J S Harris of the Monsanto Chemical Co at the ADCI meeting just mentioned, there are two ways to develop a fire-resistant fluid: (1) Start out with a fluid that inherently resists burning, such as the phosphate esters. (2) Take a fluid which in itself may be flammable and add something to it to increase its fire resistance, such as the addition of water to water-soluble glycols.

Right now there are several straight synthetic fluids that inherently resist burning and have been successfully used for industrial hydraulics. Among them are *Aroclor*, a chlorinated biphenyl; *Pydraul F-9*, a phosphate-ester-base material; tricresyl phosphate; and *Cellulube*, a phosphate ester. Both *Aroclor*, *Pydraul F-9* and tricresyl phosphate are products of Monsanto Chemical Co, while *Cellulube* (successor to *Lindol HF*) and tricresyl phosphate are produced by the Celanese Corp of America.

Aroclor has been used close to 20 years as a fire-resistant heat-exchanger fluid, a plasticizer, and in the governor-control systems of steam turbines. Back in 1932, Duquesne Light Co considered *Aroclor* for turbine bearing lubrication, but this use of it never materialized. It is basically the same material used in transformers as an insulating and heat-transfer medium in place of oil. In that role it's labeled *askarel*. *Aroclor* has eliminated the transformer fire hazard.

Water-base fluids, as described by Dr W H Millett of the Carbide and Carbon Chemicals Corp at this same ADCI meeting, are a balanced formulation of several ingredients consisting predominantly of water (between 35 and 60%), glycol plus a polyalkylene glycol thickening agent. It's the water that makes such fluids fire-resistant. Commercially available fluids have, in addition to the above, several materials introduced solely to increase corrosion-prevention properties, anti-wear and lubricity characteristics.

Development of the water-base fluids was stimulated by the U.S. Navy in its search for less-flammable hydraulic fluids for aircraft. Actually it was the Navy that coined the term *hydrolube*, widely used today in classifying fluid lubricants having substantial quantities of water as a base. About 1946, work got under way to adapt wartime hydrolubes to industry's somewhat different requirements.

First job in this transition was developing a higher-viscosity fluid for satisfactory use under continuous operation. The die-casting industry was offered its first hydrolube in 1947. This success has since been duplicated in many other industries. Today's hydrolubes are available under the trade name *Ucon* (C&CCC) and *Houghto-Safe* (E F Houghton & Co).

With the above background under our belt, let's look at what is available today in terms of potential fire-resistant turbine fluids for main bearing lubrication.

Here are available turbine fluids

People close to the turbine fluid picture in recent years feel there are four materials or approaches that are now available or show promise as contenders for the fire-resistant label: Phosphate esters, hydrolubes, oil plus a "snuffer," silicone fluid in combination with some suitable material.

Phosphate ester is a broad term that loosely labels materials, such as Monsanto Chemical Co's recently developed *OS-58-1*. This fluid is a formulated phosphate ester in combination with a chlorinated material, tailored specifically for steam-turbine use. It requires no oxidation inhibitor, but does have a rust inhibitor and foam depressant. Spontaneous-ignition temperature is above 1100 F. *OS-58-1* has gone through a series of bench tests by Monsanto, Duquesne Light Co, and the General Electric steam-turbine people. With some reservations it is now standing ready, waiting for trial runs in a steam turbine. As a cost check-point, Monsanto anticipates a price on their *OS-58-1* of about $3.00 per gallon in tank-car shipments, FOB St. Louis. This stacks up against about $.75 per gallon for a top-quality steam-turbine oil delivered.

Note the significant fact that price of one commercially available phosphate-ester-type material is quoted FOB in tank-car lots while the delivered figure is used for petroleum oil. At this time it is difficult to pin down a delivered figure for the phosphate fluid, especially in smaller shipments, but we would estimate from $3.50 to $4.50 a gallon.

In a similar phosphate-ester class is *XRL-265A*, developed by the Socony-Vacuum Oil Co, specifically for use as a fire-resistant steam-turbine fluid. This material has not only gone through the bench tests successfully, but has also seen service in the bearings and control system of a steam turbine driving a boiler feed pump at the Waterside Station of Consolidated Edison, New York City. For this test, fluid has a 200-ssu viscosity at 100 F, replacing oil of same viscosity.

Phosphate ester passes 1400-F drip test

What is the composition of *XRL-265A?* In a statement for POWER, A C Stutson of Socony-Vacuum describes it as "a phosphorous compound and halogenated hydrocarbon, with other chemicals added to improve stability, water separation and rust prevention." It has successfully passed a flammability drip-test to 1400 F. At higher temperatures it will "glow" but will not propagate flame. Hydrogen solubility of the product is about the same as for oil.

Before adding the first charge of *XRL-265A* in the Con Edison test run, the lube system was thoroughly cleaned, flushed with turbine oil and drained. *Bendix* cleaner (an alkaline material) was used to remove old paint and residue.

Turbine, operating at a 200-psi steam pressure, drives a Byron Jackson boiler feed pump rated 470,000 lb per hr at 4600 rpm. Three such feed pumps are on hand to supply a million-lb-per-hr boiler. To date, test work is not completed on this unit, but it has operated several thousand hours without any signs of serious trouble. Now let's come back to the review of promising fluids on hand.

Cellulube, made by the Celanese Corp, is a phosphate-ester material available in three viscosities: 90, 150 and 220 ssu at 100 F. This product's viscosity is determined in manufacture rather than with thickening agents. Celanese engineers, now at work on turbine fluids, state that when they have a tailored turbine fluid ready for announcing, it will be along lines similar to the present *Cellulube*.

Water-base synthetics show promise

Hydrolubes for steam-turbine *study* (not yet sold as recommended turbine fluids) are available under the trade

'Synthetic fluids need their own series of bench tests'

names of *Ucon* (Carbide and Carbon Chemicals Co) and *Houghto-Safe* (E F Houghton Co). Today's price for the *Ucon* fluids is quoted at $2.40 per gallon ordered in tank-car lots.

If the hydrolubes find their way into commercial steam turbines, their differences compared to oil must be well understood. One significant difference is in viscosity since it's imparted to a hydrolube by a water-soluble lubricant or thickening agent. Viscosity of the product can be varied by adjusting quantity of thickener in the finished formulation. And since viscosity increases as water evaporates from the fluid, viscosity measurement is a convenient check on water content.

Hydrolube suppliers furnish charts to show just how much water must be maintained in the fluid to hold its original viscosity. To avoid inhibitor precipitation, distilled, deionized or steam-condensate water is used for makeup. Control checks on viscosity are generally made at 3- to 6-month intervals in the die-casting field. After preliminary trials, many die casters find they can sidestep need for periodic water addition by maintaining fluid temperatures at a low level. Operating a hydrolube continually above 150 F is frowned on.

Combining a snuffer with a petroleum oil to build in the required degree of fire resistance is one of the approaches being followed by the Shell Oil Co. Others have tried this technique, but with little success. The key lies in selection of the most suitable snuffing material. At present Shell has no product commercially available for turbine use.

Silicones in combination with other materials may become a contender. Although a recent check with Dow Corning in Midland, Mich. indicates they are doing some development work in this direction, they have not perfected any fluid as yet. Other researchers are hard at work searching for a suitable blending agent to use with the silicones to increase latter's fire resistance.

Looking for more background?

For those who want more background information, the following list of papers and books, plus literature from companies mentioned in this article, should prove helpful:

Nonflammable Hydraulic Fluids, by Murphy and Zisman. ASLE annual meeting paper, April 12, 1949 in New York, N. Y. *Lubrication Engineering*, Vol 5, p 231 et al.

Flammability of the Higher Boiling Liquids and Their Mists, by Sullivan, Wolfe and Zisman: *Industrial and Engineering Chemistry*, Vol 39, p 1607, Dec 1947.

Aqueous Nonflammable Hydraulic Fluids, by Brophy et al. *Industrial and Engineering Chemistry*, Vol 43, p 884, April 1951.

Lubricants Today and Tomorrow, by Keyser, Socony-Vacuum Oil Co. Presented at a joint meeting of ASME and ACS in Dayton, Ohio, March 14, 1950.

Proceedings of the General Discussion on Lubrication and Lubricants . . . Oct 13-15, 1937. Published by the Institution of Mechanical Engineers, Story's Gate, St. James Park, S.W. 1, London, England.

Handbook of Dangerous Materials, by Sax. Reinhold Publishing Co.

Chemistry of Industrial Toxicology, by Elkin. John Wiley and Sons, Publishers.

Industrial Hygiene and Toxicology, by Patty. Interscience Publishing Co.

Proceedings of National Conference on Industrial Hydraulics. Oct 1953, pp 169-183.

Test methods are in for major revamp

Significant error can creep into any discussion of synthetic fluids if the same bench tests are adopted as are now used for oil. Ultimately a new series of bench tests will of necessity be devised, tailored specifically for each class of fluid. An ASTM study group is reviewing this matter at present.

Typical error that could creep in would involve adopting the present neutralization-number check to determine condition of a synthetic fluid. Many turbine-plant operators are guided by neut number results (some, however, favor the interfacial tension test) and results are satisfactory when testing peteroleum oil. However, the characteristic change in neut number of a phosphate-ester-type fluid is quite different from that of mineral oil, *sketch, p 76*. Generally, the phosphates show a gradual increase in neutralization value with a marked absence of the characteristic sharp upswing often met in testing a used petroleum oil.

Oxidation stability test (ASTM D943-47T) was recently run in the GE labs on Monsanto's fluid OS-58-1. Starting with a neutralization number 0.02, the value crept to 0.77 after 2184 hours. Serious sludging was noted at 1340 hours. Slight sludging had developed even earlier in the test.

Well-seasoned test points for neut-number checks on turbine oil have been established. But as yet there are no comparable experience figures for the phosphates. What the gradual rise in acid content indicates, and how significant it is in a synthetic turbine fluid has yet to be determined. It might well be that acids formed are relatively harmless until some critical neut value is reached.

Similar thinking holds for the hydrolubes. Here the level of corrosion inhibition or acid contamination should be checked periodically. Suppliers may differ somewhat on recommended procedure but usually a measurement of alkaline content or pH is suggested.

First telling stab in the direction of suitable tests for fire-resistant fluids was made by G V Browning and P G Ipsen, Large Steam Turbine Generator Dept, General Electric Co. Their early work in this direction was summed up in an ASME paper presented at the '54 fall meeting in Milwaukee . . . "Evaluation of Nonflammable Fluids as Steam Turbine Lubricants," ASME paper No. 54-F-36. Here you will find a critical discussion of such terms as flammability, spontaneous ignition, flame propagation.

Flammability of any material is the extent to which a material will support a continuing flame *once ignited*. Spontaneous ignition temperature, on the other hand, is the point to which a material must be heated in air before it ignites. Commonly used flash and fire test for oils (ASTM D92-52) gives limited measure of flammability. Right now we need new standard tests to pin down quantative results for fluid

Here are some tough problems yet to be licked

One critical summary of the problems yet to be hurdled is outlined for POWER by Dr George V Browning and P G Ipsen of General Electric Co. After bench-testing many of the synthetics, they feel the spotlight is focusing on two general classes of materials: (1) phosphate-ester type, possibly in combination with a chlorinated material (2) hydrolubes. Both materials show promise, but each presents problems.

Big question mark about the phosphate esters (typical would be Socony-Vacuum's *XRL-265A* or Monsanto's *OS-58-1*) is centered on their effect on electrical insulation in a turbine-generator. True, the bearing lubricant should never reach the winding insulation if seals and tolerances are in perfect condition. But long experience shows that some bearing oil does get into generator windings and we have every right to expect such leakage with the synthetics.

GE's bench tests indicate the tested phosphate materials will definitely affect many existing generator insulations adversely. *It's this point that is holding up some utilities from running full-scale tests in their turbine-generators.* But this looks like a temporary stumbling block since Browning and Ipsen state there are available insulating varnishes that are not affected by the phosphate-ester-type fluids. Headache right now is in figuring out a practical way to apply them to existing units and determining just how long the varnish film would remain impenetrable. How effective and practical simple spraying of the end windings would be has not yet been determined.

Westinghouse Research Lab people in East Pittsburgh have been scrutinizing possible turbine fluids and their effect on electrical insulations. Their findings, as summarized for POWER by Dr H E Mahncke, indicate the present phosphate-ester-type materials have a pronounced harmful effect on some generator insulations. The insulations affected most are the older asphaltic types. The newer insulations, composed of mica and a synthetic resin binder, are relatively unaffected. Present turbine petroleum oils do some harm to generator insulations but not to the degree reported for the phosphate-ester-type fluids.

Hydrolubes have their own set of problems that are awaiting solution—at least they appear as problems now, before full-scale testing in an operating turbine. First is the possible headache in maintaining proper viscosity should a water leak develop in the oil coolers or water enter the fluid from the steam. However, this maintenance of proper viscosity by watching water balance has never grown into a real problem where the hydrolubes are used in industrial hydraulics. But it may be one with steam turbines.

Hydrogen as a generator cooling medium appears to pose its own set of difficulties for the hydrolubes. Dr Browning of GE hints there may be some removal of vapor-phase inhibitors in the water-base materials through contact with generator hydrogen. A twist on this, though, was introduced by F K Fischer, manager of Development Engrg, Steam Div, Westinghouse Electric Corp. Fischer felt the mixture of water vapor from the hydrolube with hydrogen could introduce operating problems. However, he does state there was a solution on hand through the use of a hydrogen "dryer."

Hydrolubes have a milder harmful effect on generator insulations. Thinking of the researchers boils down to placing the hydrolubes somewhere between mineral oil and the phosphate-ester-type fluids in judging their effect on insulation.

Toxicity is another point that keeps cropping up when discussing modern synthetic fluids. The chemical suppliers have carefully explored this angle in connection with their past work on hydraulic fluids. General thinking to date gives a clean bill of health to both the phosphate-ester types and the hydrolubes *when used with reasonable precautions.* Complete data on this score can be had from the major suppliers.

Reaction of the synthetics with lube-system materials must be considered. First off, both the hydrolubes and phosphate-ester types are topnotch paint removers. Both soften and lift many of the conventional paints and coatings. However, suppliers of both fluids have brand lists of paints that stand up under their product. Socony-Vacuum is cautious about listing all suitable paints and sealants now: They feel a full year of field testing on their part is necessary.

Packings and seals should get some review before running tests with fire-resistant fluids. In general, hydrolubes present no problem except possibly when used with cork-impregnated seals. Replacement of cork seals with conventional rubberlike materials is preferred because of water's softening tendency on cork.

Based on published finding for *Pydraul F-9*, a phosphate-ester-type material, suitable packings and seals are available from many manufacturers (see Monsanto's latest bulletin on *Pydraul F-9* for complete list of manufacturers with type and designation of suitable packings). Apparently no "special" materials are needed—simply certain kinds of standard materials.

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cascading, fluid dripping and fluid soaking into pipe lagging. Test data on spray flammability and drip flammability of the synthetics, used as hydraulic fluids, are available from the suppliers.

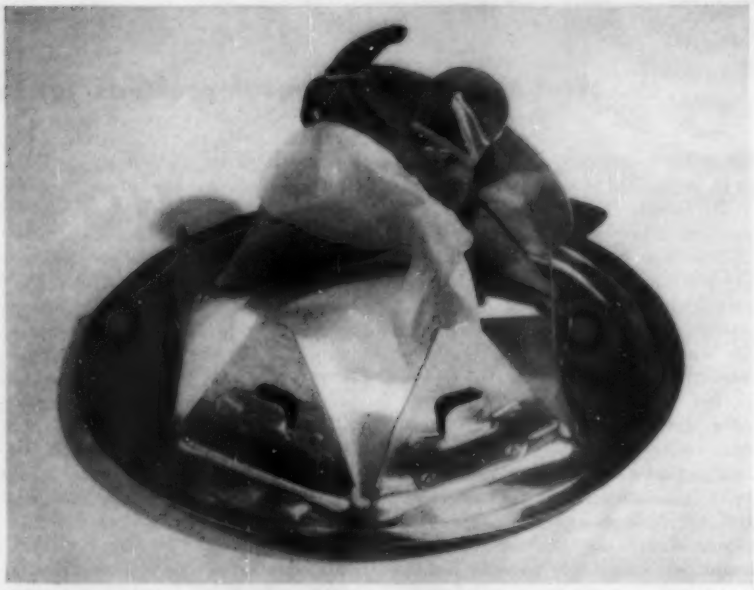
But fire resistance is not enough in evaluating any fluid. It must also be checked for lubricity, viscosity, oxidation and thermal stability, hydrolytic stability (stability of fluid in presence of water), corrosion protection, thermal conductivity, foaming and emulsion characteristics, effects on paints, metals and electrical insulation, fluid toxicity.

As Browning and Ipsen point out in their paper, any successful fluid must have a lubricity value at least equal to that of present turbine oils to insure minimum wear during gear turning and on startup. Flame propagation or flame-transfer characteristics of a fluid must also be pinpointed. Suggested test uses a strip of asbestos soaked in the test fluid and suspended vertically so tape's lower end touches a small natural-gas flame. This test might well serve to study the type fire if a slowly leaking fluid wets pipe lagging.

(*Continued on page* 222)

Part 3 of a 3-part series

By J F MYERS, *Manager, Safety-Head Div Black, Sivalls & Bryson, Inc*



1 Low-pressure prebulged rupture disk after operation. Disks of this design have sealing membrane on the product side. Lapover lugs hold center plate in place

How to select and apply safety heads for protection of pressure systems

Supports for prebulged rupture disks • vacuum capsules • disk protective coatings • designs for low-pressure jobs

► WE DISCUSSED temperature and pressure ratings for prebulged rupture disks* of various types, in Part II, pp 101-103, Feb. Users have found service life satisfactory when temperatures exceed the limits we have established, provided the system normally operates at atmospheric pressure or a vacuum.

Under these conditions it is logical to assume that life expectancy of the disk will be greater because the metal is not under a positive pressure stress, nor is it being worked by atmospheric pressure since a vacuum support restricts disk movement.

Vacuum supports. Size and pressure rating of a rupture disk being subjected to a backpressure determine if it is necessary to have a support mated to the concave (product) side of the disk. Purpose of the support is to prevent the collapse of a thin metal disk by atmospheric pressure of 14.7 psi, or a higher back-pressure.

Fig. 2 shows how a thin metal disk is affected when exposed to a backpressure, with no support used. When an overpressure develops and the disk ruptures, the support follows the same opening pattern as the disk-and-support combination shown in Fig. 4.

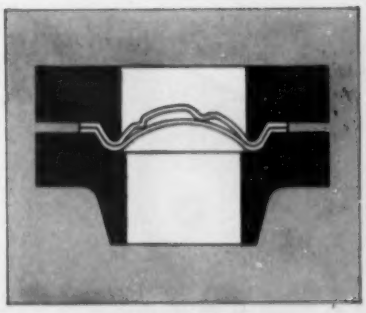
When a vacuum support is required, it becomes more important to follow the marginal variations between the normal working pressure of the system and the predetermined rating of the disk. If there is any movement of the disk from the support, attributed to pressure, or creep due to temperature, a condition like that in Fig. 3 is encountered. Purpose of the vacuum support is defeated since the space provided between the disk and support permits movement of the disk in a reverse direction by atmospheric pressure when the system is on a vacuum.

If an alternating pressure-vacuum service is involved, the disk would then be permitted flex because the vacuum support is not performing its intended function — preventing disk movement when a backpressure is imposed.

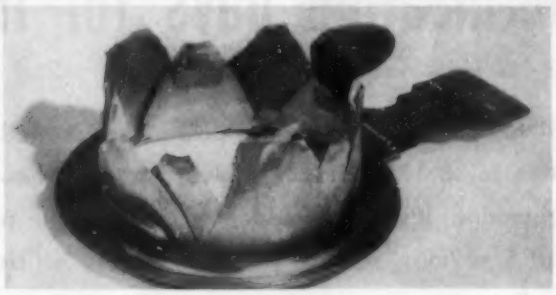
The vacuum support is fabricated with

*The recommended spelling *disk* is used throughout this article instead of *disc*. The author's firm uses *disk* to denote a flat plate, *disc* to denote a prebulged member. That distinction is not used in this article.

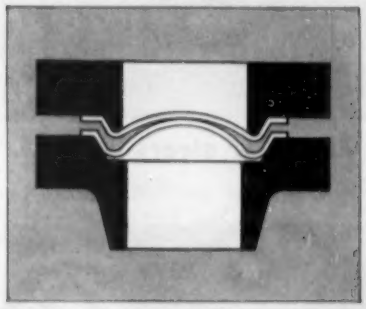
2 Effect of backpressure on an unsupported thin-metal disk used in a vacuum system. A proper support prevents this



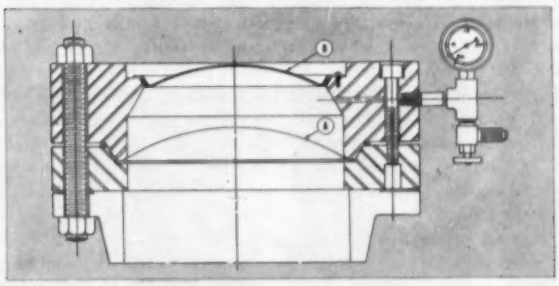
3 Movement of disk from vacuum support can lead to the condition shown



4 When an overpressure develops and a disk fitted with a vacuum support ruptures, support follows pattern shown



5 If support height is greater than disk, the condition shown may be met



6 Vacuum capsule has two disks. The rupture disk *A* is not affected in its operation by the seal disk shown at *B*

a crown height corresponding to the crown height of the disk to which it will be mated. The lot number on the rupture disk and support must correspond. If not, and the support has a lower crown height than the disk, we encounter the same difficulty shown in Fig. 3. If the support height is greater than the disk, the latter may be damaged when installed between the safety-head flanges. Stresses developed will cause the disk to rupture at a lower pressure.

Vacuum capsule. Since design limitations on the equipment to be protected may not permit a recommended tolerance between the normal operating pressure and the disk rating, we developed a unit commonly called a vacuum capsule, Fig. 6.

When movement of the disk from the vacuum support on an alternating pressure-vacuum system is anticipated, the condition in Fig. 3 being met, the vacuum support can be eliminated by use of the vacuum capsule. The rupture disk, *A*, Fig. 6, will not be affected when the system is operating or being evacuated under vacuum, since a vacuum would be maintained in the chamber between disks *A* and *B*, Fig. 6, thereby eliminating a backpressure.

Disk *B* serves only as a seal and has no bearing on the operation of disk *A*. When *A* must operate under a positive pressure, *B* is released from its seat and folds back against the flange or pipe wall. Seal disk *B* is affixed at one point on the flange by retaining screws.

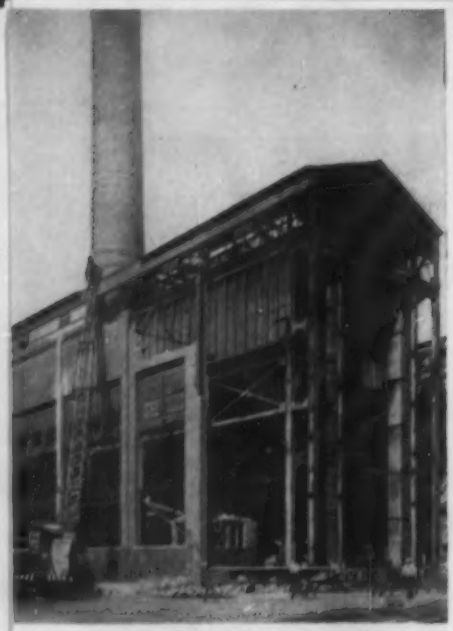
The vacuum capsule also enables us to design disks for a lower pressure rating since we are eliminating about 14.7 psi from the atmospheric side of disk *A*. Movement of this disk can be anticipated when the tolerance between the operating pressure and disk rating is closer than recommended. However, flexing of the metal, when subjected to an alternating pressure-vacuum condition, is eliminated because of the void between disks *A* and *B*.

Coatings and linings. The required size and pressure rating of the rupture disk will sometimes necessitate use of a protective coating or lining applied to either the pressure or the atmospheric side of the metal disk. A coating or lining is usually applied to metals that might corrode if left unprotected.

All coatings, either vinyl or phenolic, contain a certain amount of porosity. When a coating is used it is intended to serve as a retarder to corrosive action of the base metal, thereby increasing the service life of the disk. Much research and development, now in progress on various types of coatings, may eliminate porosity.

Linings of lead or Kel-F (trifluorochlorethylene) are widely used in the fabrication of prebulged disks. These

(*Continued on page* 220)



Goodyear clears way . . .

. . . for its modern powerhouse

A 1954 award winner

How Goodyear's $6 million modernization pays for itself

In singling out this sweeping power-service modernization for a 1954 citation, *Power* recognized sound engineering judgment evidenced by system planning, $ savings, reliability and operating efficiency

► SAVINGS OF $3000 per day—in power-service operations alone—is a tidy sum by most any yardstick. But when it's accompanied by increased system dependability, greater steam and electrical capacity, and reduced stack emission, the proposal becomes doubly attractive. And that's just how Goodyear Tire & Rubber Co's management felt when they learned of these facts.

Critical factors. Need for a sweeping power-service modernization was pinpointed in 1949 when a review of facilities showed the following: (1) 70% of steam-generating capacity—1,000,000 lb per hr—was 1910 to 1919 vintage. These older units were natural-draft chain-grate fired, designed for high-Btu deep-mine coal, although utilizing some low-Btu strip-mined coal. Operating efficiencies on them ran as low as 65%. (2) Steam- and electrical-power needs at the Akron plants were running well ahead of generating-system capacity. Expanded factory operations called for daily demands of 53,000 kw from a system whose installed summer capacity was only 47,400 kw. Purchased power was needed to supply the deficit. (3) Dust-collection equipment was nonexistent on all but the most recent boilers. To install new dust collectors on units close to 40 years old could not, of course, be justified.

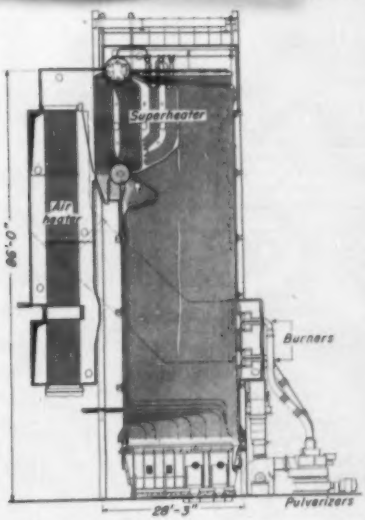
Outside consultants. Aware that these problems were placing a serious limitation on production departments, Goodyear engineers called in consultants Sargent & Lundy to help make an extensive study. Resulting recommendations paved the way for a highly efficient installation—generating 440,000-lb-per-hr steam and some 15,625-kw electrical power, with less fuel than old units needed in producing the steam alone.

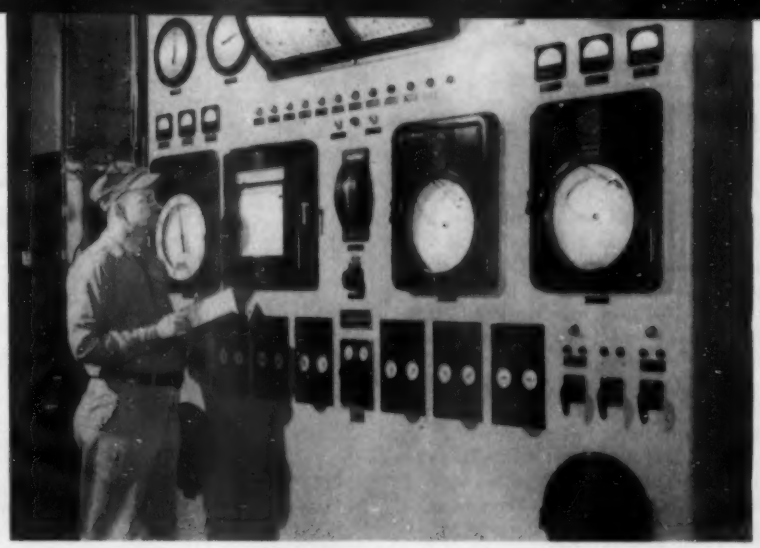
In arriving at a final design, engineers had to cope with the existing installation as well as factory needs. Lack of available space dictated removal of existing units before installing new equipment. Yet uninterrupted factory production had to be maintained. Substantially increased purchased-power requirements during the construction period were supplied with the cooperation of local utility companies.

Equipment studies covered arrangements of one, two and three boilers at pressures to 1400 psi operating on a topping-turbine cycle. Economics and plant conditions pointed to selection of two pulverized-fuel-fired units supplying 850-psig steam to a topping turbine that exhausts at 200 psig. New boilers have replaced six old 50,000-lb-per-hr units. Plant is also arranged for future expansion with a minimum of inconvenience to power-service operations.

On the pages that follow we'll focus on each of the major engineering features that have made this modernization so successful.

Power acknowledges the cooperation of L A Jackowski and C Hiss, Goodyear Tire & Rubber Co, Inc, in furnishing information for this article.

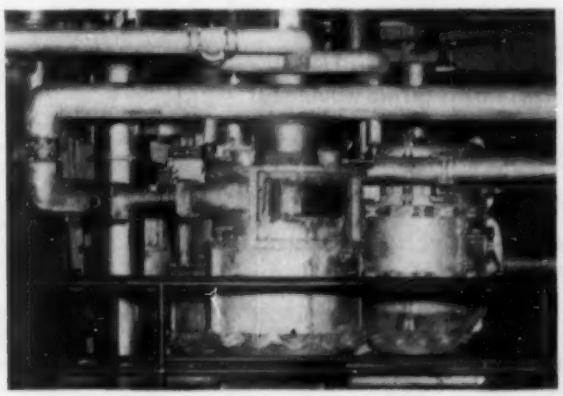




Boilers, controls designed for wide load swings, fuel-quality changes

Two new boilers, each supplying 220,000-lb-per-hr superheated steam, now occupy space made available by removing six old 50,000-lb-per-hr units. In deciding on firing methods, engineers weighed advantages of the cyclone burner against pulverized-fuel firing. Decisive factors were fuel economics and wide load variations from one shift to the next. Relatively low heating value (10,500 to 12,000 Btu per lb) and high-ash high-sulfur content of locally-strip-mined coals favored cyclone burners. But wide load swings finally dictated pulverized-fuel firing—in spite of slightly better returns on the investment for cyclone-fired units. Supplementing pulverized coal, a fuel-oil system serves for lighting off and as emergency fuel source.

Boilers are 2-drum single-pass baffleless design with tangent-tube waterwalls, superheaters and 2-section tubular air heaters. Controls are fully automatic responding to steam pressure and steam-flow air-flow signals. System is fully capable of compensating for differences in heating value of fuel commonly received at the Akron plant. Attesting to careful planning of Goodyear engineers, 1954's steam-generating efficiency saw a boost of 17% over 1948, yielding an average coal saving of 10,000 tons per month.



Coal and ash handling anticipate future needs

Coal handling posed a special problem at Goodyear—largely as a result of fitting together old and new systems. Coal feed for old plant was handled by bucket conveyors extending full length of the boiler room. Now these conveyors continue coal delivery to older boilers—and supply belt-conveyor system, above left, to new steam generators. Layout selected places the 900-psig boilers farthest from crushers and coal hoppers, and eliminates bucket conveyors from this area.

As Goodyear takes older low-pressure units out of service, portions of the bucket-conveyor system will be scrapped in favor of future belt-conveyor extensions. In effect, new additions will replace the old powerhouse, section by section.

View of ash-handling equipment, above right, shows air washer, primary and secondary dust separators mounted on top of ash silo. Bottom-ash system now services all old pulverized-fuel-fired units as well as new boilers. Flyash system handles dust-collector load from existing 750-psig boiler, and from the new steam-generating units.

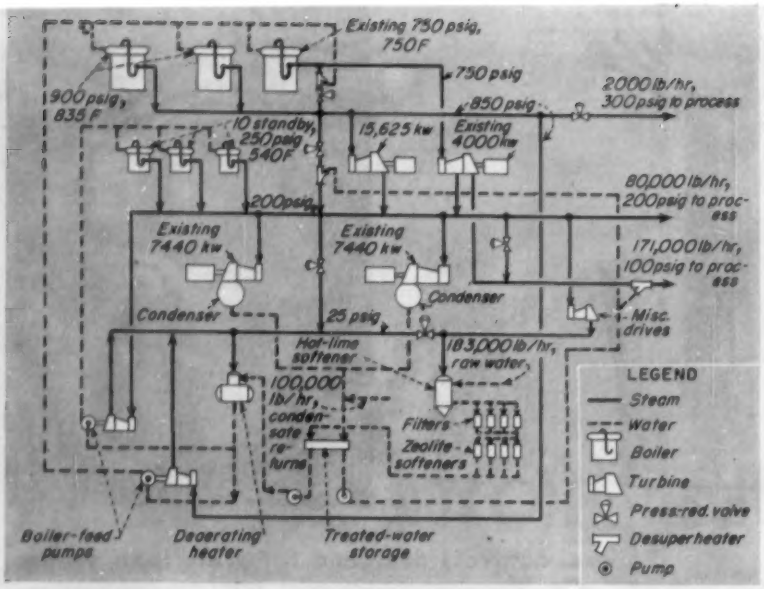
Although flyash and bottom-ash discharge to common silo, engineers have built in extra structural steel, making it easy to install a future flyash silo if commercial demand for byproduct flyash justifies installation and handling costs.

. . . now turn to hookup-design features ►

Hookup ties old to new

Hookup diagram of steam and water systems shows how electrical power, provided by this modernization, is generated entirely as a byproduct of 200-psig steam. For this use, 850-psig steam supply flows directly to new topping turbine; 200-psig exhaust steam from the topping unit feeds two condensing turbines, supplies process steam.

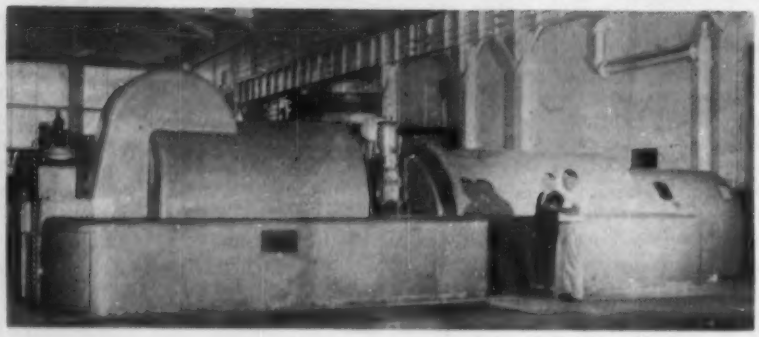
Careful system study was needed to find out best way of tying in with new equipment. Note, for example, that all pressure levels are inter-connected with desuperheating or pressure-reducing stations, or both. And maximum use of existing equipment trims system investment costs substantially.



Topping turbine trims power costs 7.6%

Topping turbine, right, is impulse-reaction design, with one Rateau stage and 16 reaction stages. Capability rating of this machine is 15,625 kw; drives 15,625-kva generator at unity power factor while capacitive or reactive kva is handled by older condensing turbine-generators.

Adding this unit to the Goodyear system cut over-all power costs by 7.6%, avoided need for purchased power.



PRINCIPAL POWER-PLANT EQUIPMENT

POWER-GENERATING EQUIPMENT

Turbine-generator, 1 ..... Allis-Chalmers Manufacturing Co
Turbine: 12,500-kw capacity, 15,625-kw capability, 3600 rpm, non-condensing, 850-psig 825-F throttle, 200-psig 525-F exhaust. Generator: 15,625 kva, 0.8 pf, 11.5 kv, 785 amp, air cooled. Excitation: 60 kw, 125 v, 480 amp, shunt wound, direct driven, 3600 rpm

STEAM-PRODUCTION EQUIPMENT

Boilers, 2 ..... Babcock & Wilcox Co
220,000 lb per hr, 975-psig design press., 835 F, pulverized-coal or oil fired, 18,345-sq-ft boiler heating surface, 4390-sq-ft furnace area, 16,200-cu-ft furnace volume, 3850-sq-ft superheater surface, 16,700-Btu-per-cu-ft-per-hr furnace heat release, 87.3% efficiency

Air heaters, 2 ..... Babcock & Wilcox Co
49,050-sq-ft heater surface, 2 sections, upper section 1914 two-in. steel tubes, lower section 1914 two-in. aluminum tubes

Pulverizers, 4 ..... Babcock & Wilcox Co
2 per unit, ball and race mills, 95 rpm, 17,250-lb-per-hr coal of 48 Hardgrove grindability

Soot blowers, 12 ..... Diamond Power Specialty Corp
4 per boiler, retractable; 2 per air heater, double arm, straight line

Primary air fans, 4 ..... American Blower Corp
16,400 cfm, 100 F, 27.1-in.-wg static pressure, 1750 rpm, 125 hp, watercooled bearings

Induced-draft fans, 2 ..... The Green Fuel Economizer Co, Inc
120,000 cfm, 335 F, 13.5-in.-wg static pressure, 1180 rpm, 450 hp, watercooled bearings

Forced-draft fans, 2 ..... The Green Fuel Economizer Co, Inc
87,000 cfm, 100 F, 15-in.-wg static pressure, 300 hp, watercooled bearings

Flyash collectors, 2 ..... Western Precipitation Corp
Multicyclone, 84% efficiency

Coal-handling system ..... Stephens-Adamson Manufacturing Co
30-in. belt, 300 tph, 340 fpm, tripper-type unloader

Ash-handling system ..... United Conveyor Corp
Flyash Nuveyor, Bottom-ash Nuveyor, 2 rotary-dustless unloaders, vitrified-tile ash silo, 186-ton capacity

FEEDWATER EQUIPMENT

Boiler-feed pumps, 2 ..... Worthington Corp
Six stage, horizontally-split casing, centrifugal, 1165 gpm, 2575-ft tdh, 3560 rpm, one turbine-driven, one motor-driven

Boiler-feed-pump turbine, 1 ..... Westinghouse Electric Corp
918 hp, 3550 rpm, 850-psig 825-F throttle, 25-psig exhaust

Condensate pumps, 2 ..... Worthington Corp
Horizontal, centrifugal, 1700 gpm, 220-ft tdh, 1750 rpm, 125 hp, motor driven

Deaerating heater, 1 ..... Worthington Corp
600,000 lb per hr, horizontal, double shell, tray type, mounted on and supported by 10,000-gal storage tank

Hot-lime softener, 1 ..... Worthington Corp
45,000 gph, 6500-gal wash-water storage, 750-gpm filter rate, 18 ft dia x 47 ft high

Pressure filters, 4 ..... Worthington Corp
8.5 ft dia, vertical, 39-in. Carbworth filter bed

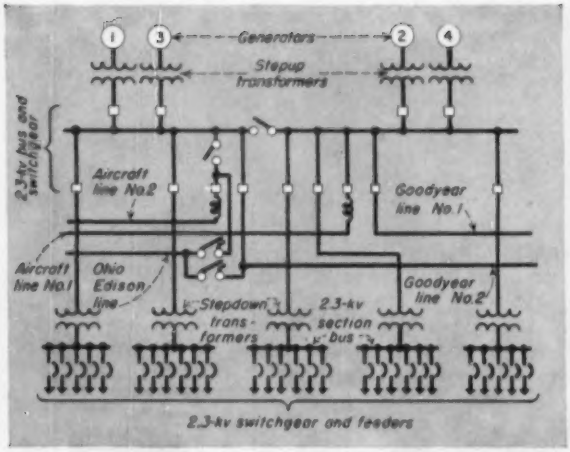
Hot-zeolite softeners, 4 ..... Worthington Corp
10,000 kilograin total exchange capacity, 750 gpm; Halcite HCR exchange material, 25,000 gr per cu ft, requires 1500-lb salt per unit per regeneration

VALVES AND PIPING

Blowdown valves, Safety and relief valves ..... Manning, Maxwell & Moore, Inc

Boiler-outlet stop check valves, Gate and globe valves ..... Crane Co

Boiler-feed stop check valves ..... Edward Valves, Inc



Single 23-kv bus proves reliable

Economical in both space and $ savings, this new switching arrangement at Plant 2 powerhouse eliminates double-bus system. Goodyear engineers point to high insulation levels, backed up by dependable circuit breakers and effective relay protection, in justifying single-bus design.

All new 2300-v switchgear is air-break type, minimizing hazard of oil fires. And while 23-kv switchgear at Plant 1 is compressed-air design, Plant 2 conditions favored low-oil-content breakers, since they could easily be substituted for similar-type old breakers. Ohio-Edison-Co utility tie shown is available but is no longer utilized.

A '55 award could make you smile too

All smiles. And why not? You'd be smiling, too, if you had just received an award for your modernization entry. Pictured, l to r, are Joe Allen, McGraw-Hill division manager, presenting 1954 awards to Bob Sheehan, manager, Pacific Mutual Building, Los Angeles, and Les Kelly, consulting engineer for Pacific Mutual's electrical-system modernization.

You can be in this picture for '55 if you completed modernizing any of your power services in 1953 or 1954—and if you enter promptly. See POWER, Jan '55, pp 80-81 or Feb '55, p 81. Or write us now for details and submit an entry.

The Goodyear Tire & Rubber Company, Inc, Akron, Ohio

Pressure-reducing valves ..... Fisher Governor Co, Swartwout Co
High-pressure piping ..... Dravo Corp

ELECTRICAL

23-kv main circuit breakers ..... Brown Boveri Corp
1000 amp, 1000 mva, air blast
23-kv main circuit breakers ..... General Electric Co
1200 amp, 1000 mva, low oil content
2300-v main-feeder circuit breakers ..... Allis-Chalmers Manufacturing Co
Metalclad, vertical lift, air break, 1200 amp, 50 mva
2300-v bus duct for transformer secondaries, Transformer ..... Allis-Chalmers Manufacturing Co
7500 kva, 24,000/2400 v, three phase, 60 cycle, oil filled
2300-v breakers for power plant auxiliaries ..... Westinghouse Electric Corp
metalclad, horizontal drawout, air break, 1200 amp, 50 mva
2300-v lighting-bus circuit breakers ..... I-T-E Circuit Breaker Co
Metalclad, horizontal drawout, air break, 1200 amp, 50 mva
Metal-enclosed bus duct ..... I-T-E Circuit Breaker Co
For transformer, generator; 4160 v, 3000 amp
Primary outdoor substation ..... Westinghouse Electric Corp
15,000 kva; three 5000-kva transformers, primary oil switches, 2300 v circuit breakers, 1200 amp, 150 mva
Primary-substation controls ..... Control Corp
Multi-conductor power and central cable ..... General Electric Co, Okonite Co
Motors ..... Allis-Chalmers Manufacturing Co, Electric Machinery Manufacturing Co, General Electric Co, Louis Allis Co, Master Appliance Manufacturing Co, Reliance Electric & Engineering Co, Westinghouse Electric Corp

MISCELLANEOUS PUMPS

Condensate-transfer pumps, Brine pumps, Filter-backwash pumps, Fuel-oil pumps, Chemical pumps ..... Worthington Corp
Sulfite pump, Phosphate pump ..... Proportioneers Inc, Div B-I-F Industries, Inc

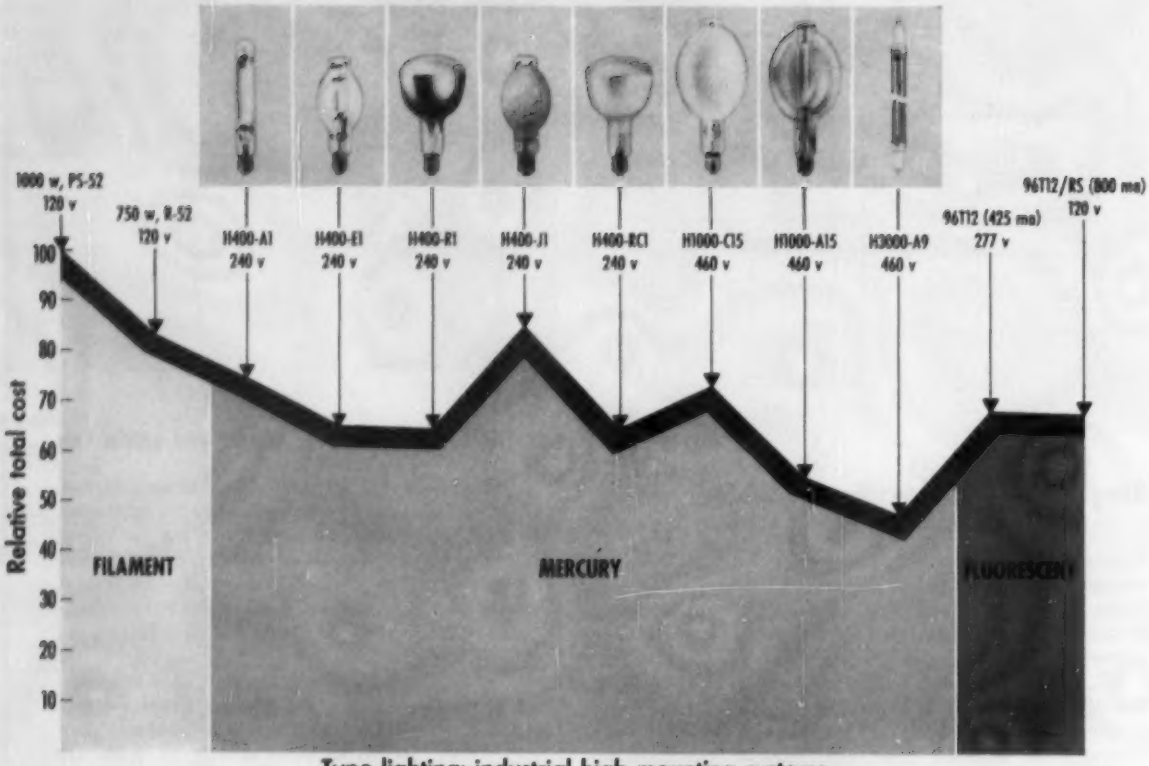
INSTRUMENTS AND CONTROL SYSTEMS

Combustion controls, Boiler, turbine panels ..... Hagan Corp
Turbine steam flow, boiler steam flow-air flow recorders, Boiler-outlet pressure, drum-water level recorders, Multiple-point draft indicators ..... Bailey Meter Co
Temperature recorders ..... Leeds & Northrup Co
Turbine-exhaust-pressure recorder ..... Republic Flow Meters Co
Pressure gages ..... Crosby Steam Gage & Valve Co
Water-level indicators ..... Yarnall Waring Co
Feed regulation ..... Copes-Vulcan Div, Continental Foundry & Machine Co
Water-column gages ..... Diamond Power Specialty Corp
Water-treatment panel and controls ..... Bailey Meter Co

MISCELLANEOUS

Elevator, 2000-lb capacity ..... Otis Elevator Co
Desuperheaters ..... Swartwout Co
Boiler-room ventilating fan ..... Clarage Fan Co
Turbine air cooler ..... Schutte & Koerting Co
Turbine-oil centrifuge ..... DeLaval Separator Co

Consulting engineers ..... Sargent & Lundy



Type lighting: industrial high-mounting systems

With color-improved designs on tap, industry is thinking:

Does it really pay to swing-over to

There's no pat answer. Some plants adopt mercury throughout for all high mounting and sing its praises. But you still must reckon with filament and fluorescent types in working out any lighting scheme for a new or old plant

By J L TUGMAN, *Lamp Division, General Electric Company*

► WHERE IS MERCURY LIGHTING finding its big market today? Briefly: in heavy industrial operations at high mountings, often above craneways, subject to dirt and grime. Here the lamps are supplying rugged, dependable lighting in spite of tough conditions and often with minimum maintenance.

High-wattage mercury lamps are generally chosen for industrial lighting. Here few units do the work for a large area, reducing the number of outlets and number of maintenance problems.

Looking back to the turn of the century we see Cooper-Hewitt mercury lighting as the standard of quality for a number of industries. For the first time there was available an extended light source, offering more light output per ampere than filament lamps. During that era the Bureau of Printing and

How modern mercury lamps operate

Mercury lamps are of two types: (1) those like the 3 kw and the various photochemical designs consisting of a single tubular glass or quartz bulb with metal electrode sealed in each end, and (2) those with glass or quartz arc tubes sealed within an outer glass jacket or bulb. Latter have main electrodes at each end of the arc tube, plus a starting electrode close to upper main electrode.

- This starting electrode is in series with a balancing resistance capsule and connects to lower main electrode. Outer bulb serves to regulate and maintain the high operating temperature of the inner arc tube. The arc tube contains a small amount of pure argon gas for starting and a small amount of mercury, which gradually vaporizes during the starting period.

- Where lamp operating voltage is about half the service voltage, simple reactors may be used to get the required voltage value for proper lamp operation. In other cases, combination auto-transformer-ballast designs are adopted.

- Mercury at normal room temperatures is a liquid and must be vaporized before it becomes a conducting vapor. At low lamp voltages the mercury is slow to vaporize and come up to full light output. For outdoor winter applications, special transformers supply the high open-circuit voltage needed to start the lamps. Lamps generally take 4 to 8 min to come up to full brightness. Don't use lag-lead 2-lamp transformers under low temperature conditions since lamp on lead circuit will either fail to light or remain at but partial brightness.

modern mercury lighting?

Engraving found mercury lighting the most desirable system for the seeing tasks in printing U.S. currency.

Experience of the twenties favored the value, serviceability of increasingly more efficient filament lamp. Industry's preference turned to the more compact filament sources that offered a more pleasing color to boot. The thirties saw this competition prompting the development of mercury lamps at higher pressures and in bulb forms competitive with filament types. Combining mercury with filaments became standard practice. During this decade mercury cut its teeth into heavy industries posing tough lighting problems.

Throughout industry a mild revolution is in progress that involves lighting and working conditions. Top management men now know any worker is more efficient and responsible if his surroundings increase his self-respect. Heavy industry has been under increasing pressure to attract better labor, keep it more efficient, free from accident anxiety. Today's mercury lamps were developed to help management meet these needs with economy, minimum maintenance.

Recent developments in the mercury picture started out with the *reflector-type* lamp. This design, like its filament prototype, maintains high light output in spite of dirt on upper surface of bulb. Next step forward came with introduction of *color-improved* version of the reflector-type lamp. In its latest form, the lamp transmits some light upward, adding a component of indirect illumination to the large amount of direct lighting.

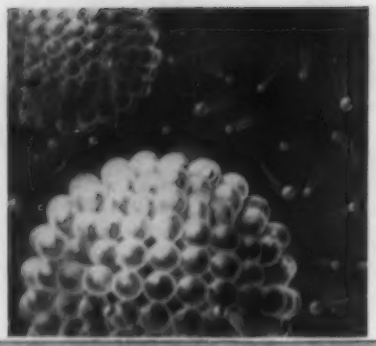
Prior to the color-improved lamp, reasonable color quality was generally achieved by combining filament lamps with mercury. And since mercury inherently requires a long starting period, this combination of sources assured some light if power were temporarily interrupted. This long-start characteristic of mercury makes it, even today, inherently less flexible than the more widely used filament and fluorescent systems. Where mercury is used, safety dictates some supplementary installation of filament lamps.

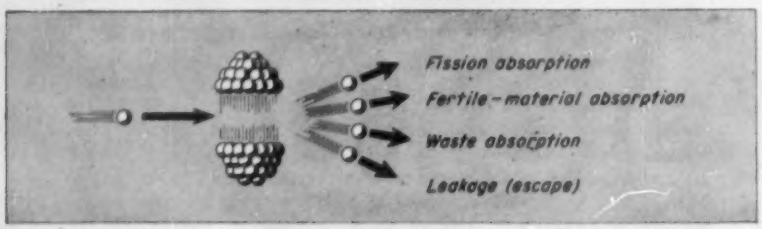
Older plants may lean in direction of color-improved mercury since results can often be had without the delay and expense of extensive rewiring. Even the inherent starting and relighting time-lag may seem unimportant when weighed against the generally lower maintenance required with mercury.

Mercury lamps, admittedly a special market illuminant, are in constant competition with filament and fluorescent. Fluorescents match mercury in life and are free from any color or starting limitations. But first cost, including wiring and equipment, favors mercury. Filament lamps get top billing for simplicity of operation and low unit cost. And they are free from color and starting problems. Remember too that both fluorescent and filaments can be applied in high industrial areas that mercury takes for its market. However, in such service the maintenance costs for fluorescent would normally be high.

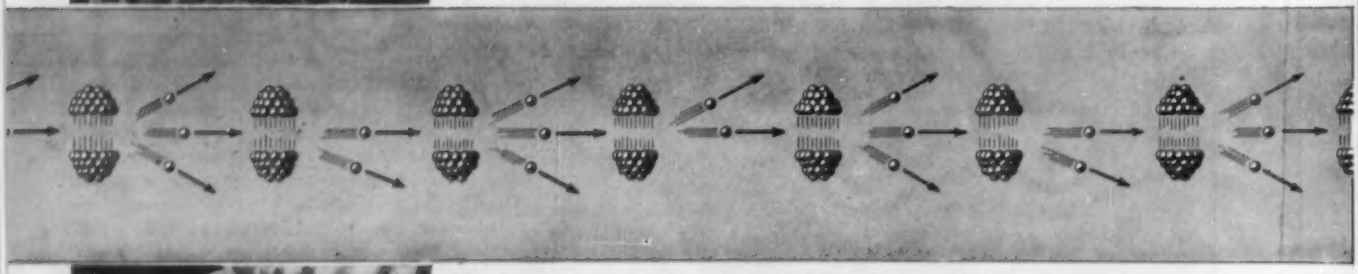
Less flexible than filament or fluorescent systems, mercury provides economies quite decisive for certain situations. *These are usually the high, hard-to-light areas where maintenance costs for other systems would be a deterrent.* Yet much depends on just how top management views plant maintenance and economy. Two areas, much alike in physical proportions, equipment and operations, may adopt mercury in one instance and a filament or fluorescent system in another. Each power-service engineer would be convinced, and rightly so, that the solution he arrived at for his particular plant was the soundest. Critical factor is often the view taken on maintenance. Where maintenance involves special labor problems, inconvenient scheduling or production losses, the mercury system is most often favored.

Now that improved color quality and upward light are available in the *RCI*, the pros and cons of mercury lighting are getting more careful scrutiny. But since no two managements reckon their production costs alike, and almost none completely integrates all contributing elements, it is tough to lay down any stringent base for selection.





1 Neutrons thrown out by fission fragments vary in number. They end up in four different ways, shown here schematically. Neutrons average 2½ per fission



2 In a steady chain reaction at least one neutron released by fission acts to split another nucleus. Excess neutrons must be absorbed to maintain constant level

Fissioning uranium and plutonium give birth to free neutrons, which can split other nuclei. How well these particles can be made to do just this depends on the . . .

Chain reaction and its control

By **HENRY C SCHWENK**, *Henry Pratt Company*
and **ROBERT H SHANNON**, *United Engineers and Constructors, Inc*

► FISSIONING U-235 NUCLEI can keep a chain reaction going because they throw out an average of 2½ neutrons each. A stray neutron from cosmic radiation or other source entering a mass of fissionable material can start a self-sustaining chain reaction.

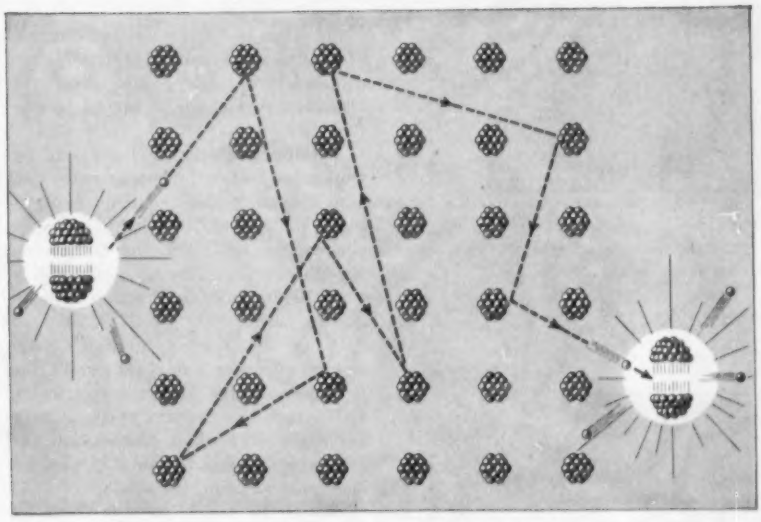
During such a reaction, however, neutrons get lost to leakage and unwanted absorption, Fig. 1. Maintaining a chain reaction depends on the balance between neutron production and losses. At least one neutron of the 2 or 3 released by each fission must split another nucleus, Fig. 2.

Fissionable materials that support a chain reaction are U-235, Pu-239 and U-233. Only U-235 is found naturally, so most reactor work has been done with this material. Fast or slow neutrons can fission any of the three isotopes. Fast neutrons can fission U-238, but the neutrons thrown out are not fast enough on the average to fission other U-238 nuclei in chain fashion.

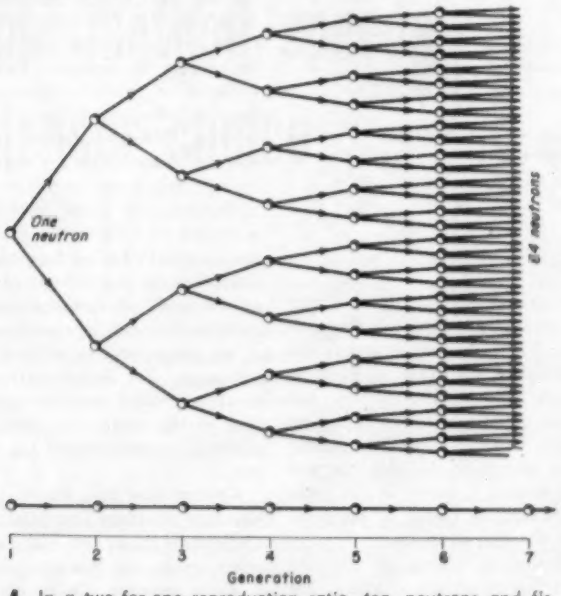
Natural uranium (99.3% U-238 and 0.7% U-235) cannot maintain a chain reaction because most of its fission neutrons have about 1 mev energy. At this level they are more apt to be absorbed wastefully by nonfissionable reactor materials than by U-235 and U-238. Adding a moderator to the fuel mixture slows down the neutrons to thermal level. This increases their chances of being absorbed by U-235 to cause fissioning, Fig. 3.

Instead of adding a moderator to natural uranium, to slow down fission neutrons, we can enrich the fuel. By increasing the amount of U-235 above the 0.7% proportion we can maintain a chain reaction with fast neutrons.

Multiplication. With each fission producing more than one neutron, the number of succeeding fissions can zoom to fantastic levels in a split second. This is the principle of the atomic bomb, **Fig. 4. Achieving this multiplication** depends on the probabilities of where the neutrons end up. Neutrons may (1)



3 Most of fast neutrons released by fissioning must be slowed to thermal level by bouncing around among moderator nuclei, before they can fission a nucleus



4 In a two-for-one reproduction ratio, top, neutrons and fissions multiply fast. In one-for-one ratio, we keep chain reaction going at a steady level to produce constant energy

escape from the reactor (2) be captured by uranium without causing fission (3) be captured by reactor impurities or structural materials. To keep a chain reaction going the fission neutrons must exceed the losses.

We can figure the probabilities of maintaining a chain reaction by using a *multiplication factor, k*. To hold a reactor at constant energy output rate at least one neutron from each fission (on the average) must split another nucleus. For this condition $k = 1$. We can define k as the ratio of the number of neutrons in one generation to the number in the generation just ahead of them. If k is greater than 1, the number of succeeding fissions grow, if it is less than 1, they become less and less and the chain reaction quickly peters out.

Fig. 5 shows how the number of neutrons grow with various values of k up to the 100th generation. The curves all start at 1 neutron in the first generation. When $k = 2$, as shown by the dotted curve, the neutrons breed rapidly. The condition is shown schematically in the top of Fig. 4. The bottom line in Fig. 4 corresponds to $k = 1$, the minimum condition for a chain reaction without growth.

The curves of Fig. 5 are based on:

$$N = k^{n-1}$$

where N is the number of neutrons causing fission in the *nth* generation. As an example lets figure the number of neutrons in the 1000th generation of a chain reaction that started with one neutron and has a multiplication factor of 1.05. This equals 1.05^{1000-1} or 1472 billion billion neutrons. Since each free neutron lives an average life of about 0.001 sec this means that in one second one neutron can "breed" this fantastic number of "offspring." These chain reactions go at lightning speed.

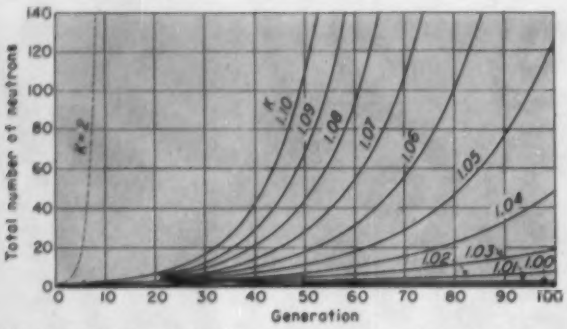
Reactor control depends on changing the value of k as needed, Fig. 6. To start a reactor we raise k above unity until we reach the power level wanted. Then by decreasing k to exactly 1.00 we hold the reactor output constant. To shut down the reactor we simply drop k below unity and the chain reaction quickly dies out.

Control rods moved in and out of the reactor core vary the value of k. The rods, of boron, cadmium, or similar material, have large capture cross-sections for neutrons. Moving the rods out of the core reduces their ability to "soak up" neutrons, which allows more of the neutrons to fission U-235 nuclei. Moving the rods in soaks up enough neutrons to stop the chain reaction.

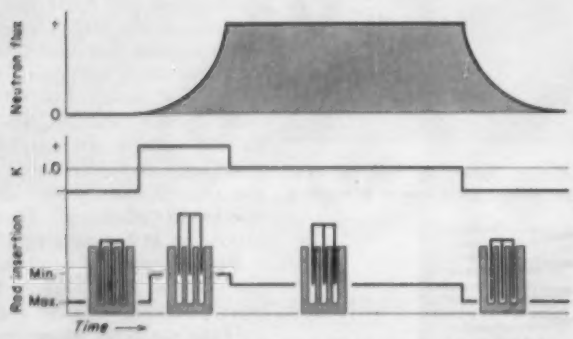
Neutron losses. To get workable k values in a reactor we must know more about the factors that control production and loss of neutrons.

In a thermal reactor using natural uranium the neutrons ejected by fissioning are fast. These will fission both U-235 and U-238. But natural uranium has a fission cross section of only 0.015 barn for fast neutrons compared to 3.92 barns for thermal (slow) neutrons. Obviously, we should moderate the neutron energy level to increase the chances of establishing chain reactions in natural uranium. The low cross section at higher energies makes a chain reaction impossible.

Enriching natural uranium with U-235 or Pu-239 makes possible a chain reaction with fast neutrons. More about this



5 Multiplication factor *k* can increase number of neutrons enormously by just a slight rise in its value above 1.00



6 Control-rod insertion in reactor core varies the multiplication factor, neutron production, and the fission rate

in a later section. But since U-238 has a fission cross section for fast neutrons some of these nuclei will split in a natural-uranium thermal reactor. In addition, a very small amount of the U-235 will fission with fast neutrons too. This factor increases the number of available neutrons. To measure this effect we have the *fast fission factor* ϵ (epsilon), which is the ratio of the total number of fast neutrons produced by fissioning to all neutrons produced by thermal-neutron fission. For a natural-uranium-and-graphite reactor ϵ is about 1.03.

For example, if there are *n* neutrons in a reactor at the beginning of a generation, they will be increased to $n\epsilon$ before being slowed down in the moderator.. During the thermalizing process we are bound to lose some neutrons to nonfission capture by U-238 nuclei. Allowance for this is measured by the *resonance escape probability*, *p*. It is slightly less than one and indicates the probability that a fast neutron will reach thermal level without nonfission capture by U-238.

Following through from our original *n* fast neutrons this means that $n\epsilon p$ neutrons eventually reach the thermalized state. These thermal neutrons are then absorbed by the uranium, moderator, coolant, structural materials, impurities and other substances in the reactor core. Those neutrons producing fission are measured by the *thermal utilization factor*, *f*, which is the ratio of neutrons causing fission to the total number of thermal neutrons.

When fissioning occurs, an average number of fast neutrons, η (eta), are produced for each thermal neutron absorbed by the U-235. Since we started with *n* fast neutrons in one generation, the following generation will have $n\epsilon pf\eta$ fast neutrons. Then we can figure the multiplication factor as:

$$k = \frac{n\epsilon pf\eta}{n} = \epsilon pf\eta$$

Of these four factors, η and ϵ are properties of the fuel and cannot be varied to any extent. But *p* and *f* can be changed a certain amount and should be made as large as possible. They vary with the nature of the fuel, arrangement of materials in the reactor, and the ratio of fuel to moderator. The latter poses a problem because *p* and *f* vary inversely with change in the moderator-fuel ratio.

Varying proportions. Increasing the amount of moderator in a reactor raises *p* to approach unity so more neutrons reach the thermal level without nonfission capture by U-238. But at the same time this reduces *f* because there will be a smaller proportion of uranium in the reactor core.

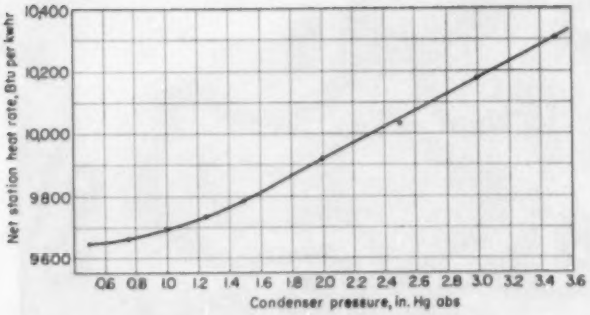
Doing the reverse, decreasing the amount of moderator, raises *f* and drops *p* because of the larger proportion of U-238 that can capture neutrons without fission. The best composition and arrangement must be found to give the maximum value for the product *pf*.

One of the easiest ways to overcome this problem uses an enriched fuel, uranium, with more than 0.7% U-235. Raising the U-235 percentage raises both *p* and *f*. Factor *p* rises because there is less U-238 and a decreased probability of capture. Factor *f* rises because the greater proportion of U-235 increases the possibility of causing fissioning. Using enriched uranium in thermal reactors means that the moderator amount can be reduced.

Theoretically these factors apply to a reactor of infinite size in which neutrons couldn't be lost by escaping. This simplifies the reasoning and introduces only a small error. Conditions of an infinite reactor can be closely approached in an actual reactor without making it too large. For design purposes only a small correction needs to be made on *k*. Size of the correction depends on the physical arrangement of the reactor materials.

Critical size of a thermal reactor is one that produces just enough neutrons to balance those lost and absorbed. In other words, one that can just maintain a chain reaction. A practical reactor must be larger than the critical size for its type design. There must be enough margin to allow "burn up" of the fuel without having an unduly short reactor life. A reactor of just the critical size would maintain a chain reaction for a short time. When the parasitic capture of neutrons by the fission products makes the total neutron loss and fission absorption exceed the neutron production the chain reaction grinds to a halt.

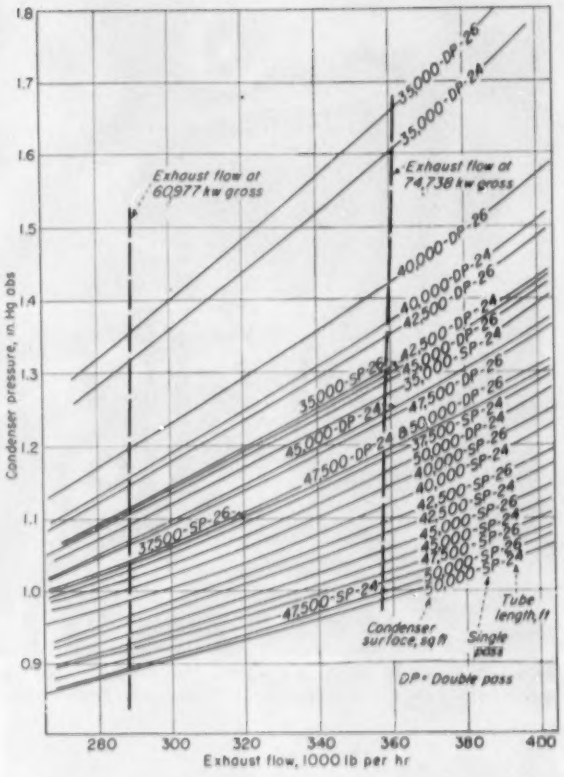
The next part will discuss basic types of power reactor designs—in a forthcoming issue.



1 Heat rate vs pressure for 75,000-kw unit in this plant

By PETER SICHEL, *Mechanical Engineer*
Gibbs & Hill, Inc

Simple method speeds condenser choice



2 Comparative performance of various condensers considered

► DETERMINING the most suitable size and type condenser for a steam turbine can be simplified by a standard calculation procedure. The method presented here is not the only one available, and others may be preferable at times. But it is simple and gives satisfactory results for most utility installations. Let's see how it is applied to a 75,000-kw turbine.

Fixed design factors. While certain condenser design characteristics lend themselves to a rigid economic analysis, other factors must be determined from operating experience, water analysis, space limitations, etc. The following fixed items were considered applicable for this installation:

Tube size ⅞-in. OD, 18 BWG; tube material, admiralty (inhibited); tube cleanliness factor, 85%; water inlet temperature, 62 F; water velocity, 6.75 ft per sec; turbine load, 75,000 kw; load duration, 3812 hr per yr; fuel cost, $0.40 per million Btu; boiler efficiency, 88.2%; auxiliary power required, 6% of gross generation; fixed charges, 16% of investment.

Reasons for adopting some of the more important factors are given below. Admiralty tube material, provided it is one of the inhibited varieties, is considered adequate for water conditions at this plant. Temperature measurements of river water over a 6-month period showed a mean value of 62 F. We consider a velocity of 6.75 ft per sec an economic optimum value for long tube life in this installation.

Since it is necessary to design the condenser for the capability of the turbine, any comparison of different condensers must be based on the nameplate rating—in this case 75,000 kw. A load of 60,000 kw or less is more representative of a mean value during the early years of operation. But use of this or a similar part-load figure distorts the comparative performance of different condensers. Operating benefits of large condensers in this plant become appreciable when load is high. Under part-load conditions the additional surface available in the large units appears wasteful.

Load duration is based on the operating period at 75,000 kw during the early years of the turbine's life.

Variable design factors, remaining to be determined by an evaluation of the over-all economy, are condenser size, number of passes and tube length. A practical range for investigating each of these was established from experience as: size, 35,000 to 50,000 sq ft; number of passes, one or two; tube length, 24 or 26 ft.

Evaluation. Variation in any of these three factors was considered to primarily affect (1) cost of fixed charges (2) fuel cost (3) power cost for pumping circulating water. These costs were determined for four standard condensers within the ranges established for investigation.

To determine fuel costs, condenser performance for each type and size was computed and the exhaust flow plotted, Fig. 2. Turbine performance, computed from plant heat balance, was based on a gross fixed output of 74,738 kw. Fig. 1 shows the variation of heat rate with vacuum.

Note that exhaust-flow changes alone are not indicative of fuel cost since changes in low-pressure drain flow, as well as exhaust-loss changes, have a marked effect on heat-rate variation with different backpressures.

Total annual cost is the sum of the three costs above. In Fig. 3, p 216, it is plotted against condenser size for each

(*Continued on page* 216)

RUGGED TERRAIN dwarfs 66,000-kw Carbon Plant and the 6-cell cooling tower standing above it. Coal, mined in the region, is delivered to the station by railroad cars, trucks (1700-ft conveyor to be added later). Short haul drops plant fuel cost

Carbon Plant—first steam-electric station in Utah's coal fields

Taking advantage of mine-mouth location raised other problems that had to be solved. Unusual conditions required building the water-supply structures some distance from the station location

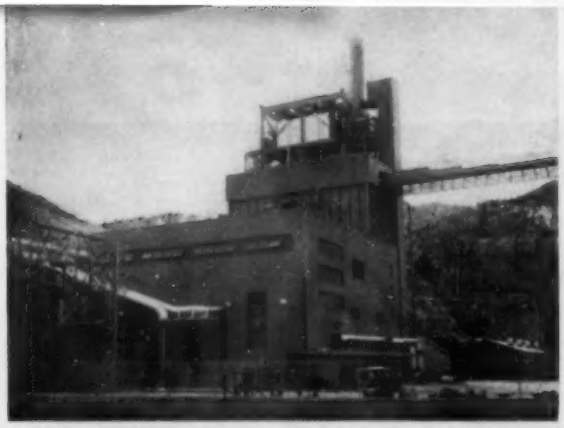
► Last December, Utah Power & Light Company placed its new Carbon Plant in commercial operation. It stands 6100 ft above sea level in a rough, barren canyon at Castle Gate, Utah. This is a coal-mining town, about 50 miles east of Provo, Utah, along the main line of the Denver and Rio Grande Western Railroad.

Fuel availability was a prime consideration in locating the plant here. Coal may be hauled by railroad or trucks from the many nearby mines in Carbon and Emery Counties. A 1700-ft 200-tph belt conveyor will be installed from the Independent Coal and Coke Co mine tipple to the plant when the over-all economics justify it. Investigations are under way to determine the effects of blending inferior coal grades with the better types normally used. The inferior products were always wasted in the past.

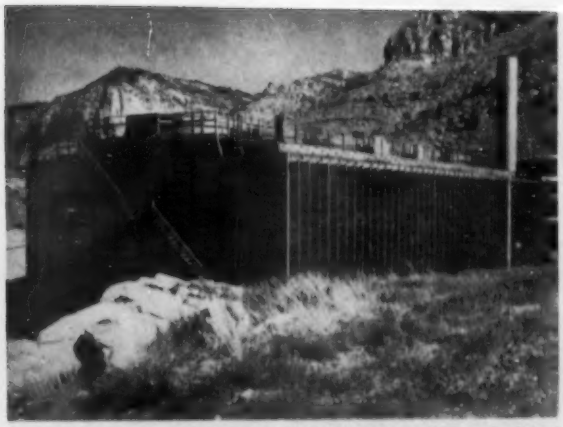
Load growth on the entire Utah Power & Light system, and particularly in the east central and southeastern parts of the state, led to choosing the Carbon site. The 66,000-kw plant brings the installed system capacity to 490,000 kw. Carbon Plant ties into the Utah Power & Light system through 44- and 130-kv lines.

The semioutdoor plant uses the unit system. One 620,000-lb-per-hr steam generator feeds the 66,000-kw 1250-psig 950-F turbine.

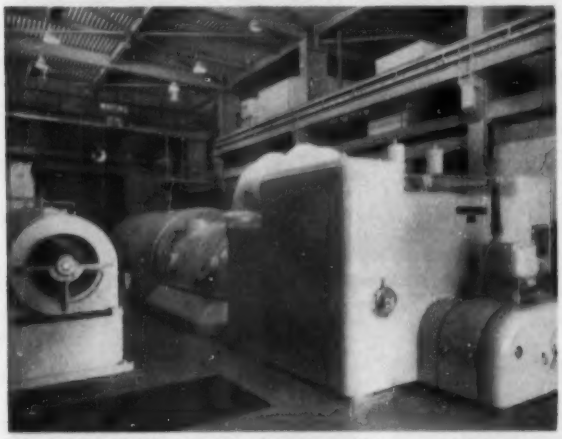
To find a solid rock foundation for No. 1 unit and a future No. 2, part of a rock bluff was cut away. The mountains and cliffs dwarf the appearance of the plant. Limited water supply requires using a cooling tower for circulating water. The tower stands on a hill next to the plant, about 80 ft above the operating floor. Water flows from the tower basin through two 42-in. lines to the circulating pumps standing in the turbine room. The pipes are made of $\frac{3}{8}$-in. plate, all welded,



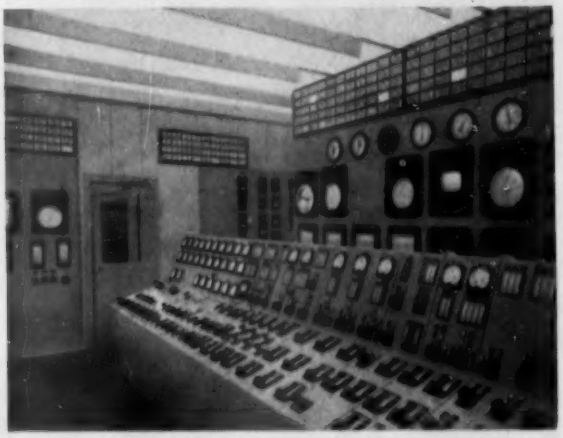
SEMIOUTDOOR STATION has low-head turbine room, completely enclosed in metal siding, and an outdoor steam boiler



INDUCED-DRAFT COOLING TOWER has six cells, each fitted with 40-hp fan, is on hill about 80 ft above operating floor



TANDEM-COMPOUND TURBINE uses 1250-psig 950-F steam and exhausts at 2.5 in. Hg abs with 561,000 lb per hr flowing



CENTRAL CONTROL ROOM uses miniature instruments on the console-type bench boards, and large-type annunciator boards

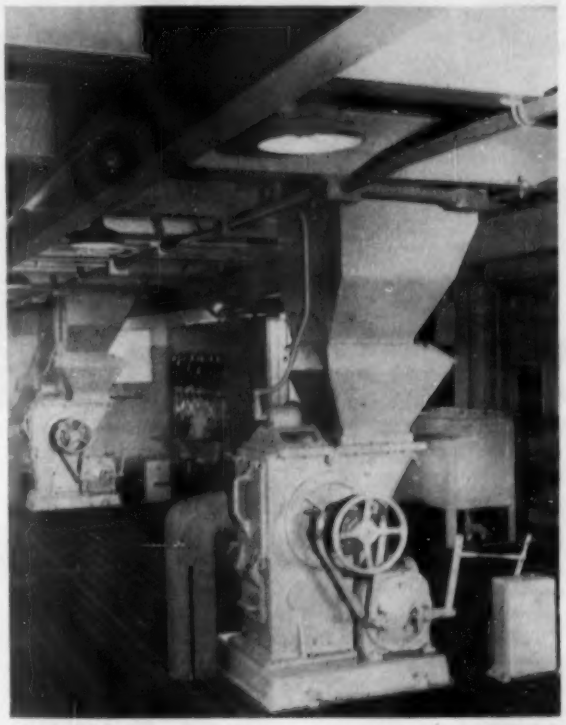
and designed for a normal total operating pressure of 70 psi.

Water supply. Makeup and service water for the plant is taken from the Price River. While the river flows past the plant, the water is diverted about 1½ miles upstream into a large settling basin. Plant water comes primarily from two wells some 14 miles upstream from Castle Gate. The two wells, 1500 and 2000 ft deep, provide roughly 1200 gpm each. They discharge into the Price River.

About 500 ft above the settling basin a diversion dam and side-channel spillway direct the water to the basin. The spillway acts as a primary desilting chamber. Flashboards on the dam give way during floods to prevent water with high silt loading from entering the desilting chamber.

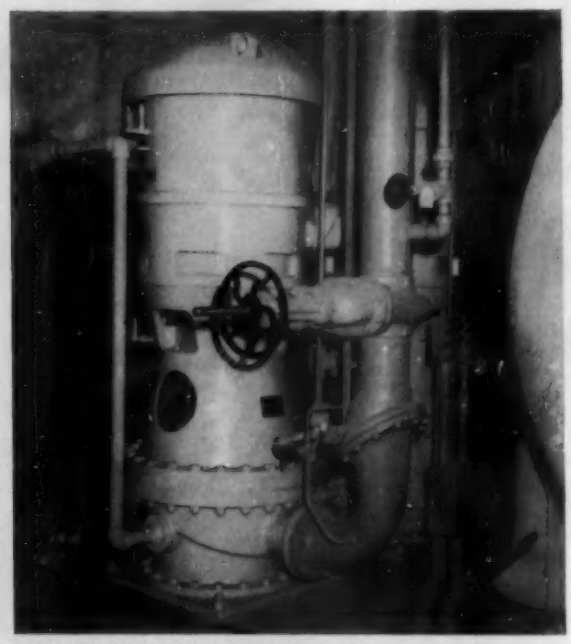
The desilting chamber feeds into a concrete outlet structure which has a weir and a 1-in. bar grizzly. At the bottom of this structure an 18-in. steel pipeline feeds the water to the settling basin. A sluicing line and gate adjacent to the outlet structure can be used to flush out the chamber periodically, discharging accumulated silt into the river downstream of the dam.

The supply line from the desilting chamber enters a manually operated manifold at the head end of the settling basin. Three lines run from the manifold: one to the basin, one to the river and one bypass to the basin outlet structure. The manifold regulates water level in the basin, at the same time

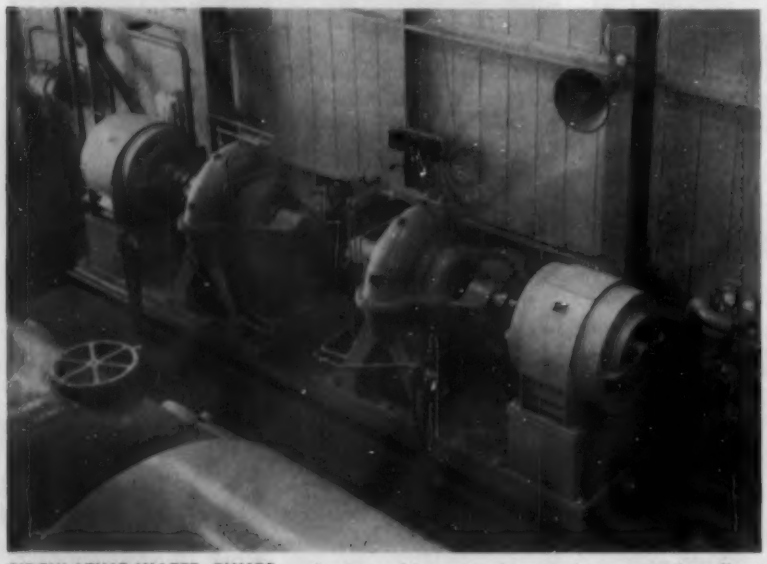


COAL FEEDERS supply 15 tons per hr each to bowl-mill pulverizers below. Boiler-water sampling board stands at rear

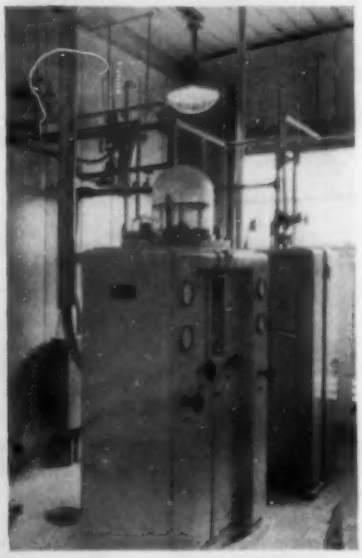
DEAERATING FEEDWATER HEATER and its storage tank stands outdoors on the roof of the station enclosed auxiliary bay



VERTICAL CONDENSATE PUMPS, standing next to main surface condenser, deliver 1000 gpm each at a 370-foot head



CIRCULATING-WATER PUMPS and motor drives stand on turbine operating floor above main condenser. Pumps take water from condenser, discharge to tower basin



CHLORINATING EQUIPMENT discharges into the cooling-tower basin outlet line

maintaining enough flow in the supply line to prevent silt settling out in the pipe. In addition, the basin can be bypassed completely while it is dewatered for cleaning. Two dewatering lines lead to the river.

The settling basin in addition to removing silt from the water holds about 2,500,000 gallons in storage in case the river flow is interrupted. The basin outlet structure maintains the water level in the basin and has a continuous overflow back to the river. It has a single traveling screen and an automatically controlled wash pump.

Water leaves the outlet structure through an underground 12-in. pipe that leads to a raw-water sump in the service building of the plant. A control valve at the sump regulates the gravity flow through the 8000-ft-long line.

Domestic water supply in the plant comes from the Castle Gate system. All boiler-water and cooling-tower makeup, as well as service water, is taken from the raw-water sump.

POWER gratefully acknowledges assistance of J N Landis and W H Ness of Bechtel Corp. and W W Bowman of Utah Power & Light Company.

PRINCIPAL POWER-PLANT EQUIPMENT

Carbon Steam-Electric Plant, Castle Gate, Utah, Utah Power & Light Co

POWER-GENERATING EQUIPMENT

Turbine-generator, 1 ..... Westinghouse Electric Corp
66,000 kw, 1250 psig, 950 F, 2.5 in. Hg, 5 bleed points, tandem compound, double flow, 81,176 kva at 15-psig H_2 pressure

Condenser, 1 ..... Westinghouse Electric Corp
Radial flow, 2-pass, deaerating hotwell, divided waterbox, 45,000 sq ft, 39,000 gpm cooling water, 3000-gal hotwell capacity

Condenser tubes ..... Chase Brass & Copper Co
7568 tubes, ⅞-in. OD, admiralty, 25 ft-11½ in. long (effective)

CIRCULATING-WATER EQUIPMENT

Circulating-water pumps and motors, 2 ..... Westinghouse Electric Corp
Double suction, volute, horizontal, single stage, 20,100 gpm, 71-ft head, 506 rpm, induction motors, 450 hp, 2,300 v, 3 ph, 60 cycle

Cooling tower, 1 ..... Marley Co
Induced draft, cross, double flow, 39,000 gpm, 6 cells, 22-ft fans driven by 40-hp motors

Cooling-tower makeup pumps, 2 ..... Ingersoll-Rand Co
Centrifugal, horizontally split, single-stage volute, 2000 gpm, 160-ft head, 1750 rpm

Tower makeup pump drives, 2 ..... General Electric Co
100 hp, 440 v, 3-phase, 60-cycle, 1750 rpm

Traveling screen, 1 ..... Chain Belt Co
Totally enclosed, chain operated, wire-screen baskets, spray system

FEEDWATER EQUIPMENT

Condensate pumps and motors, 2 ..... Westinghouse Electric Corp
Vertical pit, multistage, 1000 gpm, 370-ft head, 1170 rpm, induction motors, 150 hp, 440 v, 3-phase, 60-cycle

Boiler feed pumps, 2 ..... Ingersoll-Rand Co
Centrifugal, 7-stage, barrel type, 1650 gpm, 3940-ft head, 3550 rpm

Boiler feed pump hydraulic couplings, 2 ..... American Blower Corp
Scoop type operated by Bailey Meter Co control drive

Boiler feed pumps' drives, 2 ..... General Electric Corp
Induction motors, 1750 hp, 3585 rpm, 2300 v, 3-phase, 60-cycle

Feedwater heaters, 4 ..... Westinghouse Electric Corp
Horizontal, U tubes, integral drain coolers:

Heater	Sq ft	Removable	Tube metal	Shell press.	Tube press.
No. 1	2070	Bundle	Admiralty	50 psig	300 psig
No. 2	1580	Bundle	Admiralty	100 psig	300 psig
No. 4	2270	Shell	Cupronickel	250 psig	2100 psig
No. 5*	3100	Shell	Cupronickel	500 psig	2100 psig

*desuperheating zone

Deaerating feedwater heater, 1 ..... Worthington Corp
600,000 lb per hr, horizontal, double shell, tray type, external vent condenser, 1000 cu ft storage

Evaporator, 1 ..... Westinghouse Electric Corp
320 sq ft, single pass, horizontal, cupronickel tubes, 12,900 lb per hr vapor output, submerged straight-tube thermal descaling

Evaporator preheater, 1 ..... Worthington Corp
Deaerating type, 14,010-lb-per-hr capacity

Evaporator feed pumps, 2 ..... Ingersoll-Rand Co
Single stage, single suction, centrifugal, 40 gpm, 3450 rpm

Evaporator feed pump drives, 2 ..... General Electric Co
Drip-proof induction motors, 5 hp, 440 v, 60-cycle, 3490 rpm

STEAM-GENERATING EQUIPMENT

Boiler, 1 ..... Combustion Engineering, Inc
Single drum, 620,000 lb per hr continuous, 1355 psig, 955 F, 45,300-cu-ft furnace, 27,490-sq-ft waterwalls, 12 adjustable, tangential coal burners, 8 adjustable tangential mechanical atomizing oil burners, fuel-oil pilot torches and automatic electric ignition system, 2-stage 19,000-sq-ft superheater, burner-tilt and spray-type desuperheating control, 28,100-sq-ft horizontal finned-tube economizer with temp rise from 438 to 563 F

Air preheater, 2 ..... Air Preheater Corp
Ljungstrom regenerative, vertical, 75,700 sq ft

Steam air heaters, 2 ..... Griscom-Russell Co
Finned tube, 315,000 lb per hr at 51 F

Soot blowers ..... Copes-Vulcan Div, Continental Foundry & Machine Co
16 deslagger blowers for furnace walls, 8 long retractable for superheater, 8 rotary for economizer, 600-psig blowing steam, automatic sequential operation

Forced-draft fans, 2 ..... Westinghouse Electric Corp
127,500 cfm, 100 F, 12-in. wg, 1185 rpm, inlet vane control, outlet dampers, single induction motor drives both fans, 600 hp, 2300 v, 1190 rpm

Induced-draft fan, 1 ..... American Blower Corp
395,000 cfm, 350 F, 15.5-in. wg, 575 rpm, variable speed through hydraulic coupling, outlet louver dampers

Induced-draft fan drive, 1 ..... General Electric Co
Induction motor, 1250 hp, 2300 v, 3-phase, 60-cycle, 590 rpm

Dust collectors, 2 ..... Western Precipitation Corp
Multiclone, mechanical type, 7 hoppers

Ash-handling system ..... United Conveyor Corp
Pneumatic with automatic sequential control, 15 tph, 4 clinker crushers, 1 mechanical exhauster, 1 steam standby exhauster, 2 rotary ash unloaders, 2 air washers

Ash-storage silo, 1 ..... The Lang Company
20 ft diameter, 33 ft high

COAL-HANDLING EQUIPMENT

Car shaker, 1 ..... Link Belt Company

Conveyor belting ..... Thermoid Western Co

Belt weightometer ..... Fairbanks Morse & Co

Primary coal crushers, 300 tph ..... Stephens-Adamson Mfg Co

Coal-handling conveyors ..... Stephens-Adamson Mfg Co
200 tph, car unloading hoppers, transfer tower, stacking-out conveyor, reclaim conveyor

Coal pulverizers, 3 ..... Combustion Engineering, Inc
Bowl mill, 27,800 lb per hr coal

Coal scales, 3 ..... Stock Equipment Co
15-tph capacity, 300-lb hopper

PIPING AND VALVES

Steam and boiler feed piping ..... Midwest Piping Co, Inc

Circulating-water piping ..... Structural Steel & Forge Co

Spring hangers ..... Grinnell Co

Expansion joints ..... Zallea Brothers

High-pressure gate, check valves ..... Chapman Valve Manufacturing Co; Crane Company; Wm Powell Co; Manning, Maxwell & Moore

Steel gate, globe and check valves ..... Chapman Valve Manufacturing Co; Crane Company; Manning, Maxwell & Moore; Walworth Company

Instrument valves ..... Wm Powell Co; Stockham Valves & Fittings Co; Edward Valves, Inc

Iron and bronze valves ..... Chapman Valve Manufacturing Co; Crane Company; Wm Powell Co; Walworth Company

Relief valves ..... Manning, Maxwell & Moore

Bleeder trip valves ..... Atwood & Morrill Co

Butterfly valves ..... R-S Products Corp

MISCELLANEOUS PUMPS

Boiler test ..... Aldrich Pump Co
Horizontal double-acting air pump, 3 gpm, 3150 psig

Boiler wash ..... Ingersoll-Rand Co
Two-stage centrifugal, 200 gpm, 294 ft, 3450 rpm

Air-heater drip ..... Ingersoll-Rand Co
Single-stage centrifugal, 21 gpm at 380 F, 235-ft head, 3450 rpm

Fire, gasoline driven ..... Worthington Corp
Seven-stage vertical turbine, 750 gpm, 250-ft head, 1770 rpm, Ford V-8 industrial engine with right-angle gear

Fire, motor driven ..... Worthington Corp
Single-stage centrifugal, 750 gpm, 150-ft head, 1750 rpm

Fuel oil ..... Ingersoll-Rand Co
Five-stage centrifugal, 110 gpm, 1065-ft head, 3500 rpm

Igniter oil ..... De Laval Steam Turbine Co
Rotary displacement IMO, 1.4 gpm, 65-ft head, 870 rpm

MISCELLANEOUS EQUIPMENT

Combustion and feedwater controls ..... Bailey Meter Co
Mini-line, pneumatic type. Console board, recorder panel and oxygen analyzer panel

Television ..... Diamond Power Specialty Corp
Closed circuit, 115 v, 60-cycle, 75 mm, f2.7 camera lens, air cooled

Lube-oil filter and conditioner, 1 ..... Bowser, Inc

Lube-oil purifier, 1 ..... De Laval Separator Co

Air compressors, 2 ..... Ingersoll-Rand Co
Horizontal, single stage, double acting, 211 cfm, 100 psig

Air dryer, 1 ..... Pittsburgh Lectrodryer Corp
Dual tower, activated alumina as desiccant

Air filters and reducing manifolds, 3 ..... Bailey Meter Co

Water-treatment equipment ..... Permutit Co
Filter, hydrogen zeolite and sodium zeolite softeners, degasifier, treat 50 gpm

Chlorination equipment ..... Wallace & Tiernan Co, Inc

Turbine-room crane, 30-ton main, 5-ton aux hoist ..... Whiting Corp

Elevator, 1 ..... Otis Elevator Co
Passenger, 3000 lb, 100 fpm, automatic self-leveling

Tanks, miscellaneous ..... Hammond Iron Works

ELECTRICAL EQUIPMENT

Main transformer, 75,000 kva, 13.2/132 kv

Station-service transformer, 7500 kva, 13.8/2.4 kv ..... General Electric Co

Crank-up transformer, 7500 kva, 42/2.4 kv

Main oil circuit breaker, 1 ..... General Electric Co
Oil blast, pneumatic operated, 138 kv, 1200 amp, 3-pole, 3,500,000-kva 5-cycle interrupting capacity

Oil circuit breaker, 44-kv ..... General Electric Co
Oil blast, pneumatic operated, 600 amp, 500,000-kva 8-cycle interrupting capacity

Isolated phase bus ..... General Electric Co
15 kv, 4000 amp, extruded aluminum hollow-square conductors, aluminum enclosures

2400-v switchgear ..... General Electric Co
Metalclad, indoor, dead front, horizontal drawout

480-v load centers, 4 ..... ITE Circuit Breaker Co

Station relay board ..... Western Switchboard Co

125-v dc switchgear ..... Western Switchboard Co

Lighting distribution unit, 112.5 kva ..... General Electric Co

Lighting panelboards, 3 ..... Trumbull Electric Dept, General Electric Co

Coal-handling control board, 1 ..... Cutler-Hammer, Inc

Station storage battery ..... Electric Storage Battery Co
60 cells, 125 v, 560 amp-hr at 8-hr rate to 1.75 v per cell

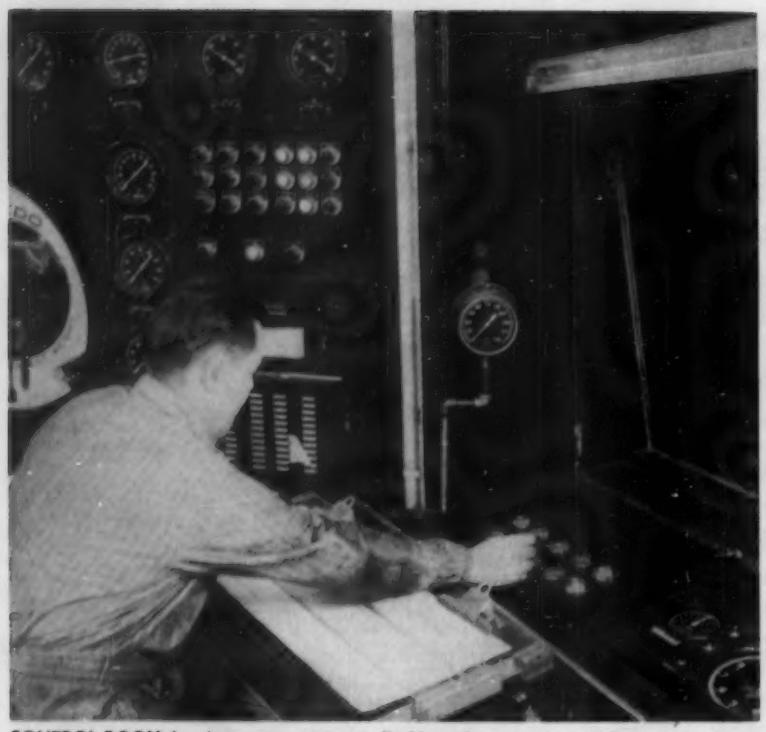
Battery-charging m-g sets, 2 ..... Electric Products Co
Diverter pole, 7.5-kw generator, 129/140-v dc; 15-hp 1800-rpm 440-v 3-phase induction motor

Annunciator system ..... Control Corp

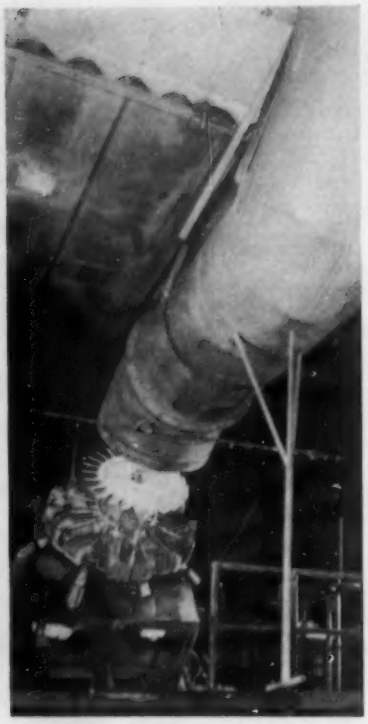
Telephone system ..... Stromberg Carlson Co

Public-address system ..... Stromberg Carlson Co

Engineers and Constructors ..... **Bechtel Corp**



CONTROL ROOM for dynamometer test cell. Here the operator is adjusting the vane-control switch to correct air volume. Millivoltmeters indicate engine temperature



UPPER portion and ceiling of flight-test cell showing one of 36-in.-dia air ducts

Good planning and design will provide

Testing of aircraft engines presents unique problems to the air-conditioning engineer. Here are design details of one of the most modern and comprehensive test installations now in use

► At the Jefferson Avenue plant in Detroit, the engine division of Kaiser Motors Corp tests Wright Cyclone engines, rated from 800 to 1200 hp for complete acceptance—qualification and durability—by the U.S. Air Force. Air-moving and cooling equipment plays an important part in this work.

Flight-test cell. To provide adequate facilities, the existing building was lengthened and its height increased, giving a total working area of some 50,000 sq ft. Equipment and instrumentation on this project are considered to make it one of the most modern and comprehensive of its type.

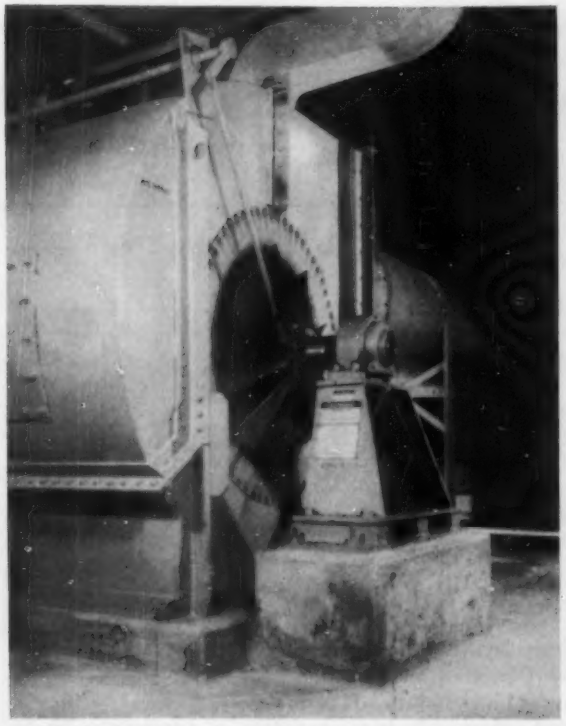
Simulating actual flight conditions, engines are tested in a flight-test cell, a chamber 70 ft high and 20 ft square. The engine is mounted on a 10-ft test stand, either in a horizontal position, or at a 38-deg incline if it is intended for helicopter use.

During flight tests, engine head temperatures are controlled by auxiliary air. Since the engines must be tested over a specified range of temperatures, accurate control of air volume is important. This needed sensitivity is found in the vane controls, which are a part of the Westinghouse *Airfoil* centrifugal fans providing the blast of cool air controlling the temperature of the engine.

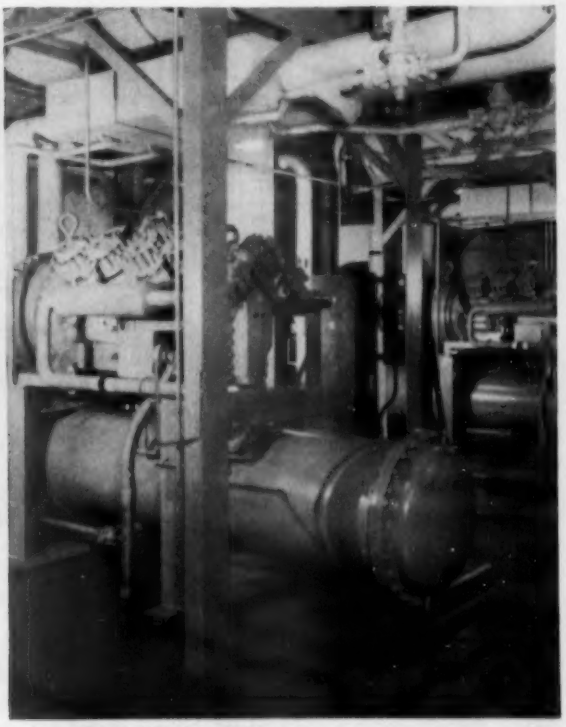
Air supply. When Smith, Hinchman & Grylls, architects and engineers, laid out this project, specifications called for 77,000 cfm of 70-F air at 17-in. static pressure. This provides for the possibility that larger engines may be tested in the small cell.

Each fan was to be powered by a 300-hp motor. Power requirements were predicated on the fact that most fans of this type operate at best with 80% efficiency. The fans installed operate at 92% efficiency, because of reduced cascade effect, resulting from the blade design. This gives a power saving of 50 hp on each fan.

Considering actual operating time—150 hr per month flight-testing periods and 50 hr per month of dynamometer tests—a total saving of about $225 per year is obtained by this reduction in power requirements. Fans for this installation are both double width, double inlet, arrangement 3, Class 4, with inlet-



CENTRIFUGAL FAN for primary cooling of flight-test cells discharges through either of two 36-in. ducts to the cells



5 REFRIGERATION COMPRESSORS, each rated 100 tons, provide air conditioning for engine carburetors and the test building

top-efficiency air-conditioning units

vane controls. They are driven by direct-connected 250-hp 1750-rpm motors.

One fan supplies air to the flight-test cell, through either of two 36-in.-diameter ducts. Discharge of the duct ends a few inches ahead of the flight propeller hub. One duct is designed for horizontally located engines, the other for those mounted on an incline. A system of manually operated blast gate valves determines the path of the air.

The second fan, also a Westinghouse *Turbovane* unit, supplies air for the three dynamometer test cells, which are pressurized to 16-in. H_2O static (pressure on cell walls is 82 psi). Air flows from the pressurized chamber through the cowl, over the engine and into the cell. It is exhausted from the cell by axial fans in the exhaust stacks.

Control room is on the same level as the mounted engine. For the flight-test cell, the control panel includes a millivoltmeter connected with a thermocouple, in the engine head. Engine-head temperatures are varied from 416 to 500 F, depending on the power range, propeller pitch and manifold pressure. Air volume is controlled by a switch, which actuates the mechanism of the vane control. Limit switches, on the control board, indicate end of vane travel by turning on red lights.

Cooling plant also includes a 500-ton air-conditioning system that cools air in the entire building, including one flight-test cell, three dynamometer cells, eight propeller cells, as well as some of the comfort and office cooling.

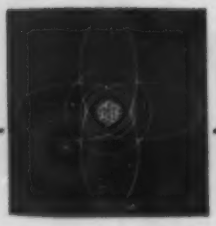
The prime purpose of the cooling plant is to provide air conditioning for the carburetors. Installation comprises five 100-ton chilled-water systems producing 50-F water. Each of the 12 test cells is provided with an individual carburetor air-supply system. Air handled in these systems has a constant temperature of 70 F, plus or minus 2 F, and a 70% humidity.

Cooling loads between 50 and 500 tons can be handled by the five Westinghouse type CLS-3400 compressors. The integral 100-hp 1160-rpm motors. The availability of five, separately maneuverable units, allows for flexibility of the system.

Before cooling, air enters through louvers in the intake stack, some 60 ft above the ground. Filtered, it passes to a plenum chamber. A steam preheat coil and a chilled-water cooling coil are also fitted. For carburetor feed, air is reheated by a steam coil to the required temperature of 70 F.

Each refrigeration unit has its own dry-expansion-type water chiller, water-cooled condenser and chilled-water pump.

A cooling tower on the roof supplies the water for condenser circulation. Three water pumps, piped in parallel, handle 1500 to 2000 gpm. Water temperature is controlled by a programing motor activated by a pneumatic device and a group of limit switches.



Nuclear notes

By B G A SKROTZKI, *Associate Editor*

Australia's first nuclear reactor and "atomic city" will be built about 20 miles from Sydney, capital of New South Wales. The reactor will be about twice the size of Britain's unit at Harwell, England. About $12 million will be spent for scientific laboratories, engineering workshops and other buildings. Australian uranium, refined in England, will fuel the reactor. The coastal site will make it easier to dump radioactive wastes at sea.

Nuclear-fired Shippingport Plant, of Duquesne Light Co, will probably have its turbine-generator portion built by Burns and Roe, Inc, (associated with J Rich Steers, Inc and Hatzel & Buehler, Inc) as the general contractor. They may also do a certain amount of work on the reactor portion, subject to AEC approval.

An atomic clock makes it possible to measure time with greater accuracy than ever before. Prof C H Townes of Columbia University invented the "maser" (microwave amplification by stimulated emission of radiation), which produces electrical oscillations of 24 billion cycles per second—directly from the radiation of ammonia molecules. Researchers will use it for radio communication, microwave transmission and reception, navigation; and to check the earth's rotation speed as well as to examine structure of atomic particles with greater precision.

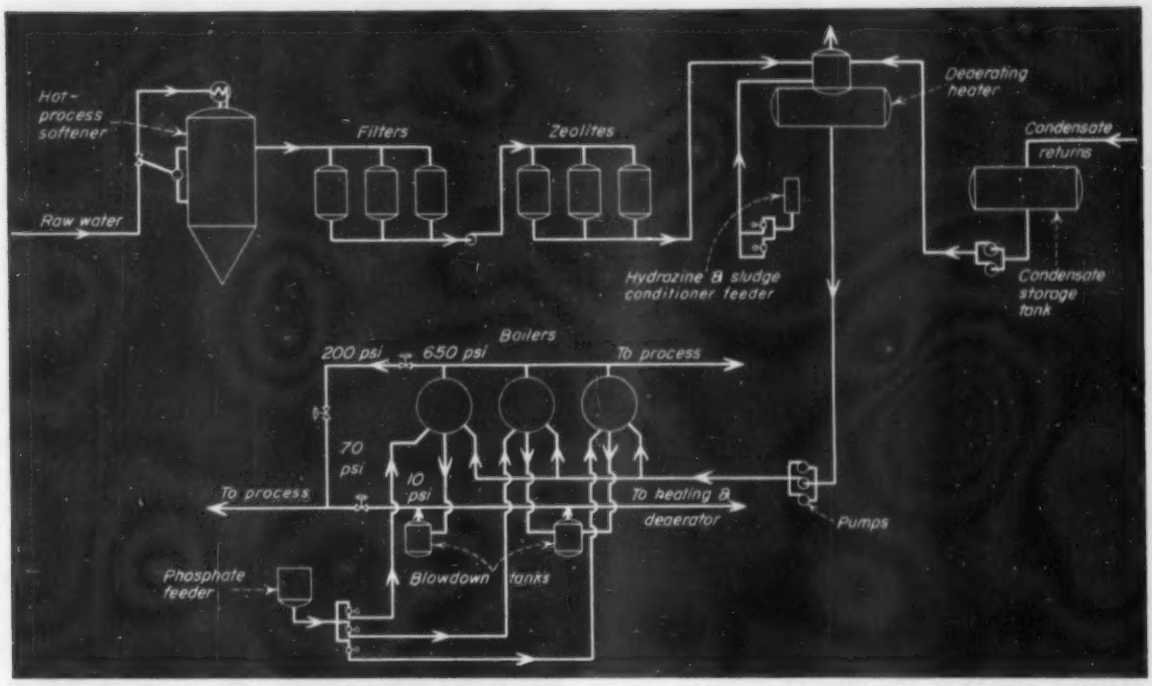
We need more science students, says W F Libby, AEC Commissioner. Ablest boys shun science because: (1) They think only geniuses can make new discoveries. (2) Scientists are low paid. (3) Instruction in high-school science could be better. (4) Colleges do not give good introductory science courses. Practising engineers could help schools by working as part-time faculty.

Nuclear power study by the Consumers Public Power District of Columbus, Nebraska, has been approved by AEC. The District expects to spend about $100,000 in making a year's study of reactor development, and the engineering and economics of atomic power. Generating capacity of the district is more than 85,000 kw.

First industrial research reactor to be owned and operated by private industry has been planned by American Machine & Foundry Co. Firms in the fields of electronics, petroleum, food, pharmaceuticals, chemicals, ceramics, rubber, metals, textile, agriculture, machinery and others have been invited to join this cooperative program. Each will be represented on a board of directors. The reactor and its laboratories will be built near New York at a cost between $1.0 and $1.5 million. It could be running within 18 months. AMF is also building a reactor for Battelle Memorial Institute about 15 miles west of Columbus, Ohio.

West coast atomic conference, sponsored by Atomic Industrial Forum and Stanford Research Institute, is scheduled for April 4 and 5 in the Mark Hopkins Hotel in San Francisco, Calif. More than eight speakers will talk about: nuclear power plants, industrial research reactors, process heat and radiation, cold sterilization, petroleum production and use, finance, insurance and education.

Your teeth and radioactivity seem to have little in common. But one toothpaste manufacturer had teeth made radioactive in the Oak Ridge reactor of the AEC. By using various toothpastes on the exposed teeth and measuring radioactivity of the washings he found which one caused the least abrasion with adequate cleaning.



STEAM-WATER CYCLE flow diagram at Doe Run petrochemical plant. Hydrazine is fed to feedwater at the deaerator discharge

Hydrazine finds new field: industrial plants

Boiler feedwater at petrochemical plant in Brandenburg, Ky. has been treated with hydrazine since May 1954—with good results. Here are their experiences with the oxygen scavenger

By R V MONTVILLE, G R JENKINS and E R WOODWARD
Olin Mathieson Chemical Corporation

► SEVERAL high-pressure boiler plants in both Europe and the United States have used hydrazine successfully as an oxygen scavenger in feedwater. Boiler pressures in these units range mostly from 900 to 1850 psig—primarily central power station conditions.

How about lower-pressure boilers in industrial plants? Would hydrazine be of any value in this field wherever dissolved oxygen is a problem in feedwater or boiler water? To answer this question, we have been using it at our Doe Run petrochemical plant, a good example of the typical industrial plant.

Equipment at Doe Run is shown in flow diagram above. Three 80,000-lb-per-hr boilers supply 650-psig steam at 750 F from 235-F feedwater. Average winter steam demand is about 207,000 lb per hr, reducing in warm weather to about 190,000 lb per hr.

Makeup water varies from 40 to 60%. Raw water comes from deep wells and is conditioned in turn by a hot-process lime softener, filters and styrene-zeolite softeners where hardness is finally reduced to about zero.

Internal treatment. In May of last year, we stopped using catalyzed sodium sulfite and switched to hydrazine as the oxygen scavenger in the boiler feedwater. Sodium sulfite had been used for this purpose since the plant started operation in 1951.

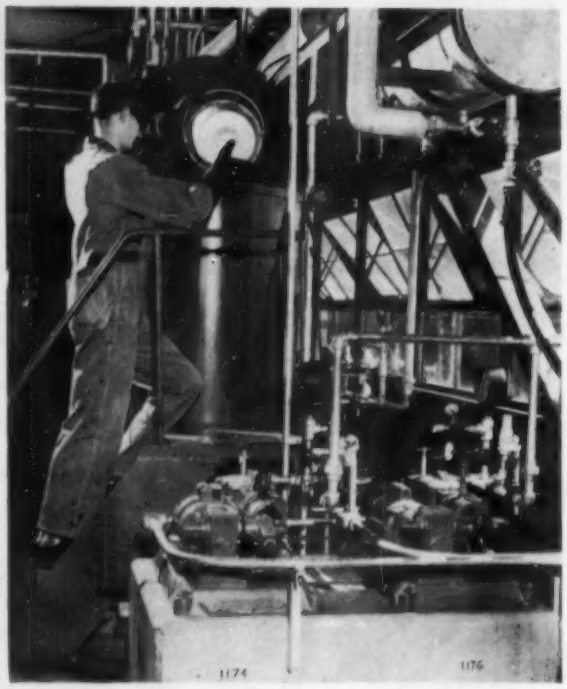
Initial treatment called for 0.5 ppm added to feedwater to insure oxygen-free water. A few hours' operation showed this to be in excess of what was needed. Operators reduced hydrazine feed gradually, while keeping constant check on oxygen content of feedwater. This set the minimum amount of hydrazine needed to maintain oxygen-free water at less than 0.1 ppm. Or, in other words, three boilers need ⅜ lb hydrazine per 24 hr of operation.

Sludge-conditioning anti-foam chemical is fed to feedwater along with the hydrazine, as when sulfite treatment was used. Equipment remained the same when switch was made from sulfite to

DRAWING HYDRAZINE SOLUTION (54.4% active material) from supply drum into one-gallon polyethylene bottle. Operator is protected with rubber gloves and goggles. Sign tells him to use soap, plenty of cold water if hydrazine contacts skin

MAKING UP a 24-hour supply by weighing needed amount of concentrated hydrazine solution while pouring it into cold water in weighed pail. Strong hydrazine hydrate is no more hazardous than many other chemicals used daily in industrial plants

Only a reasonable amount of care is needed in handling, feeding hydrazine solution



POURING partly diluted hydrazine solution into mixing tank, which contains about 50 gallons of water and usual amount of sludge-conditioning anti-foam chemical. Steam-water cycle and chemical feed location are shown on preceding page

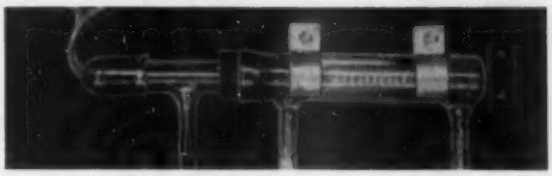
hydrazine—no alterations were needed.

Critical inspection of two of the boilers was made after 3500 and 3800 hr of continuous operation with hydrazine. Exposed metal surface above steam-drum-water level received special attention. No oxide pitting or corrosion was found. See photos on p 102 for mud-drum and steam-drum appearance.

Material found inside mud drum after 3800 hr operation consisted of a small deposit of soft nonmagnetic powder. The entire boiler gave up only a quart of this powder and the tubes looked clean. Recent experience indicates that when hydrazine is used instead of sulfite for water treatment, metal surfaces inside the boilers can be cleaned much more easily. Brushing is all that is needed to remove powdery deposit.

Handling precautions. Hydrazine came to the plant in a 30-gallon stainless-steel drum containing about 240 lb of 54.4% hydrazine solution. Reasonable care is needed in handling the material.

Photos above show operator feeding 24-hr supply to mixing tank. Entire mixture is agitated for one hour to insure complete mixing. Proportioning pumps feed chemicals into downcomer of the deaerator between deaerating section and storage compartment. Best



Testing for hydrazine by amperometric method

SCOPE

This method covers detection and quantitative estimation of hydrazine in water solution ranging from zero to 0.05 ppm. It is especially useful in finding small amounts in feedwater. You can measure larger amounts by dilution of sample with oxygen-free water or by iodate titration.

Procedure uses microammeter connected to silver-platinum electrode, which is immersed in sample of water to be tested.

APPARATUS

1. Platinum-silver electrode, shown above, inserted in flow vessel. The inside of electrode is first packed nearly full with silver-oxide granular powder. Then 20% sodium hydroxide is added to fill remaining air space. Electrode is stored in 20% NaOH solution.
2. Microammeter with range from zero to 50 microamperes.
3. Flow vessel for testing flowing samples as shown above. Diameter of this cell can be reduced for greater agitation if needed.
4. Stirring apparatus for use with nonflowing spot sample tests.
5. Sample container, 250- or 500-ml wide-mouth Erlenmeyer flask fitted with one-hole rubber stopper for nonflowing tests.

REAGENTS

1. Sodium hydroxide solution, 20% strength.
2. Silver oxide powder.
3. Distilled water, free of dissolved oxygen. To prepare, boil water in flask to remove dissolved oxygen and cool in vacuum or under a blanket of inert gas, such as nitrogen.

SAMPLING

Take spot samples for nonflowing tests in wide-mouth Erlenmeyer flask, mentioned above. Fill flask from bottom using rubber-tube-extension from sampling-tube outlet. Change contents of flask several times by allowing it to overflow continuously for about five minutes at a flow rate of 500 ml or more per minute. Then withdraw tube slowly and insert freshly rinsed stopper in full flask of water. Test sample as soon as feasible.

Take flowing samples by using plastic or pure-gum-rubber tube to connect sampling tube to bottom or inlet nozzle of flow vessel. (Flowing test rig shown above is on side, top is at left.) Connect top or discharge nozzle to drain. Maintain sample flow rate at about 400 ml per minute, or enough to give agitation needed for maximum response from electrode and microammeter unit.

PROCEDURE

For nonflowing spot samples, immerse electrode in water sample and stir with it. (Or stir with mechanical stirrer of motor or magnetic-driven type. Where flow vessel is used, stirring is not needed.)

If microammeter reading is more than 50 microamperes, dilute fresh sample with measured amounts of oxygen-free water until you get satisfactory readings. Multiply result by number of dilutions. If you get no reading, no appreciable hydrazine is present. (A negative reading may mean the leads are reversed.)

Get ppm by multiplying microampere reading by factor obtained from calibration tests or by reading calibration curve.

operating efficiency results if chemical supply tank is emptied and refilled once every 24 hours.

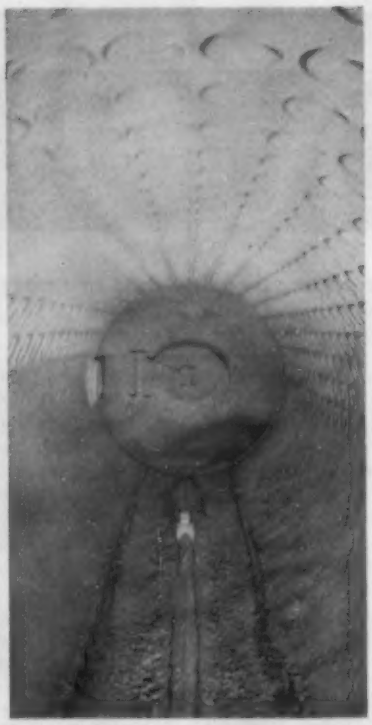
Control method. General use of hydrazine in industrial-plant boilers calls for simple, adequate methods for control of residual hydrazine in boiler water. It should be possible to train operators without specific technical knowledge to run the tests with sufficient accuracy. Here are the tests we use at Doe Run.

Dissolved oxygen is determined by the Winkler test. Accuracy is possible because of the purity of the water at the discharge of the feedwater pump.

Feedwater hydrazine content is measured by an electrophotometric method. It depends on the reaction of hydrazine with paradimethyl - amino-benzaldehyde —this dye reacts with the hydrazine to form an azine and, therefore, is selective in testing for this chemical. Color developed is measured on an electro-photo-meter—ppm hydrazine being read from the standard calibration curve. (Data for plotting the calibration curve are obtained by preparing a series of solutions of known concentration of hydrazine and reading the color developed.)

This method has a sensitivity well within the range needed for boiler operation. Several different persons ran

NO CORROSION was found in boilers after about 3500 hr continuous operation



STEAM DRUM, *left*. In mud drum, *right*, small deposit was soft and nonmagnetic

Chemical cost is lower with hydrazine

tests and got good results down to the lower limit of 0.002 ppm hydrazine. Test as now set up at Doe Run has an upper limit of 0.05 ppm. Hydrazine content at feedwater pump discharge runs 0.002 to 0.004 ppm.

The amperometric analyzer, developed by Mathieson's Dr John F Haller, is another method for measuring hydrazine content in boiler feedwater. It is described in the block on p 101.

This analyzer was tested by deliberately raising and lowering the hydrazine feed to the boilers. Changes were indicated within a few minutes. The test was performed several times and it was found that the readings were consistently correct. We are now making plans to adapt this amperometric analyzer to a recording instrument for charting hydrazine residual in water.

Steam quality at the plant is checked by instrumentation and by chemical tests. *Conductivity* and *pH* are measured by recording instruments, and run from 2.4 to 2.8 micromhos and from 6.4 to 6.8.

Ammonia in the steam is measured by the Nessler method using a Hellige color comparator. The purpose of the ammonia test is to avoid an excess, and to check for possible decomposition of hydrazine to ammonia in the boiler water and steam cycle. Maximum ammonia content measured in the steam was 0.2 ppm with an average of 0.08 ppm.

Process steam and *returned condensate* are checked for hydrazine by the electrophotometric method. No hydrazine was found. Check of steam from each boiler separately showed similar zero result.

Boiler blowdown is checked for any accumulation of hydrazine in the boilers. Here the direct iodate method is used. It makes use of a water-soluble dye as an internal indicator. Hydrazine content is determined by titration with iodate solution. During normal operation the reducing material present was between 0.1 and 0.2 ppm.

Test methods described above, with the exception of the photometric hydrazine determination, can be performed easily by nontechnical personnel at the boiler plant. With the Haller cell in operation, hydrazine residual is indicated with sufficient accuracy so that only an occasional referee check using the photometric method is needed. Tests described are sufficient to control the addition of hydrazine to the boiler feedwater.

Advantages in using hydrazine instead of sodium sulfite as an oxygen scavenger are numerous. There is no problem of dust, dirt and broken paper bags as the hydrazine solution is shipped in stainless-steel containers.

No additional total solids are imparted to the boiler water. Because of this, boilers are cleaner, less scale-forming sludge is present, all adding up to more efficient boiler operation and better heat transfer.

In plants where storage space is limited, hydrazine offers a decided advantage. A 240-lb drum of this chemical occupies a very small area, whereas the sodium sulfite needed to treat the same amount of feedwater would occupy approximately 30 times as much floor space.

The Doe Run plant realized a direct saving in chemical cost by changing from sulfite to hydrazine for feedwater treatment. The following figures bring this out:

Treating 4,580,000 lb of feedwater per day calls for 10 lb of catalyzed sodium sulfite as against $\frac{3}{8}$ lb hydrazine hydrate. Ten pounds of sodium sulfite at 11.4c per lb give a daily cost of $1.14. But $\frac{3}{8}$ lb of hydrazine hydrate at $1.55 per lb amounts to 58c, or a saving of 56c per day. This amounts to a $204.40 yearly saving in chemicals alone.

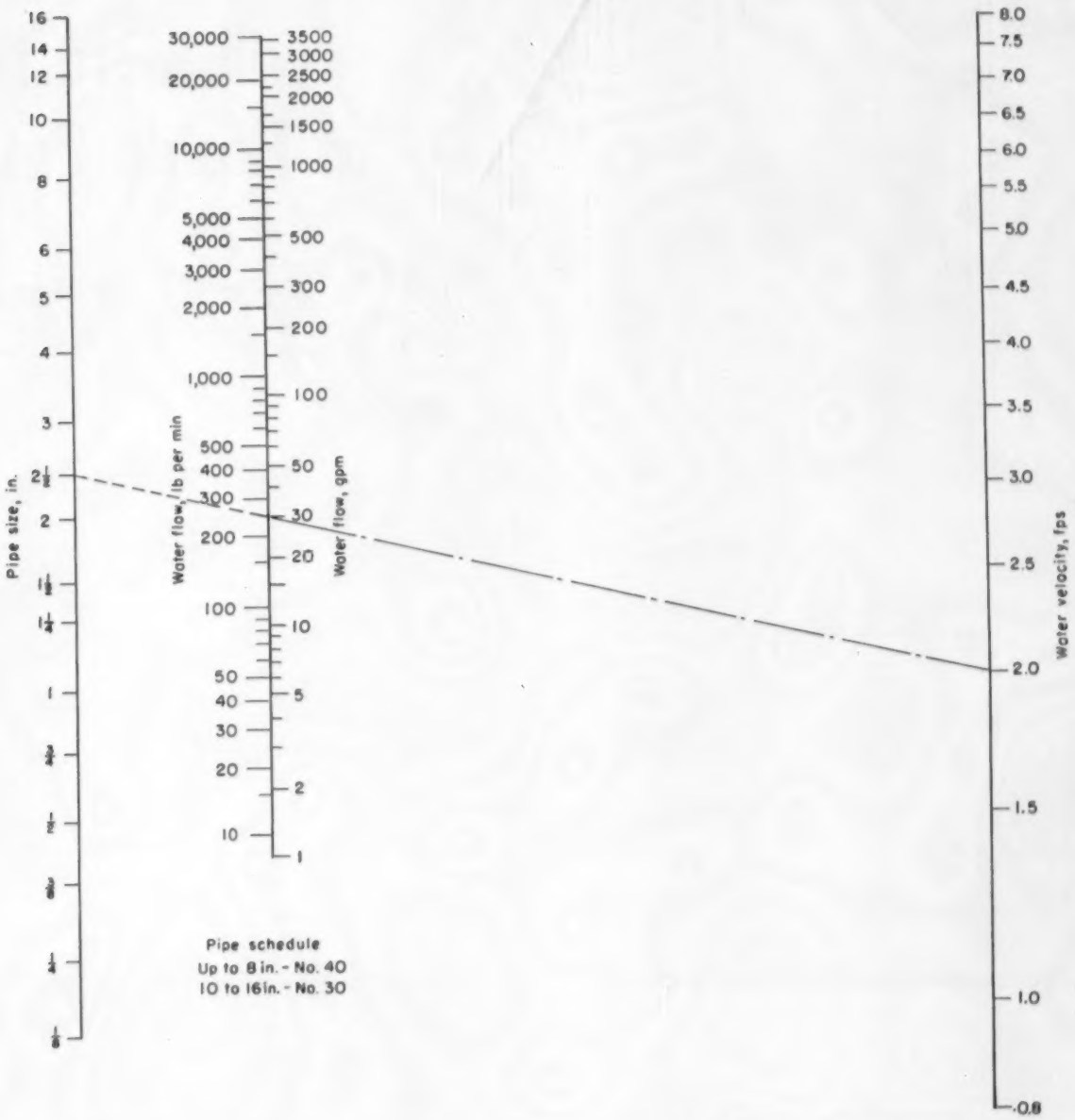
Summary

- Operation at this plant shows hydrazine as the most efficient boiler-water oxygen scavenger.
- Typical hydrazine residual in the boiler water is 0.10 ppm.
- Chemical cost for hydrazine is less than for sodium sulfite previously used. The saving amounts to $204.40 per year.
- Boilers were found to be almost free from deposit after 3500- and 3800-hr operation.
- Solutions of hydrazine require no more handling precautions than other chemicals commonly used in boiler-water treatment.
- Time required for boiler cleaning has been greatly reduced.
- Hydrazine, being a liquid needed only in very small amounts for the daily charge, has a decided advantage for storage and handling.

Experience in this plant shows that hydrazine has a definite value as an oxygen scavenger in boilers operating in industrial plants.

Power's DATA SHEET

No. 273



Water flow in standard steel pipelines

Example: With a water velocity of 2 ft per sec in a 2½-in. steel pipe, find the gallons per min (gpm) transported through the line.

Solution: Find the 2½-in. pipe size on the left-hand scale. Connect this point with a straightedge to the 2 fps on the right-hand scale. On the center scale find, at the intersection with the straightedge, a reading of 30 gpm. The adjacent scale shows this equal to 250 lb per min. Multiplying by 60 gives equivalent flow of 15,000 lb per hr.

A J Jackson *Hartford, Conn.*

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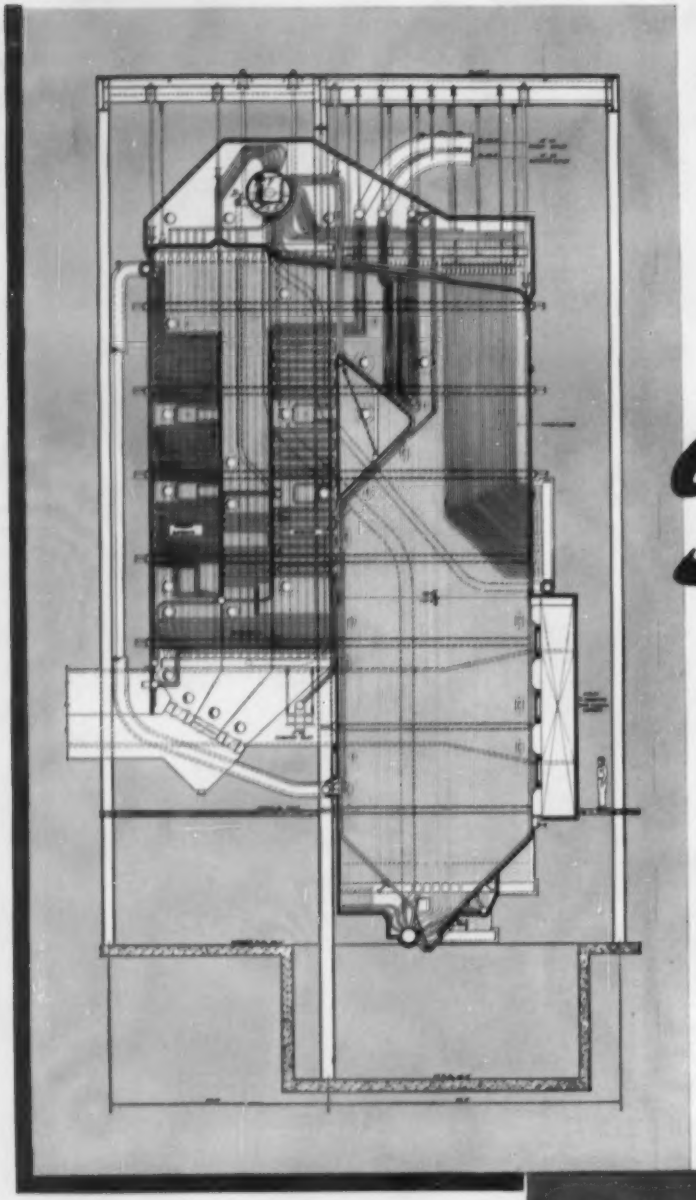


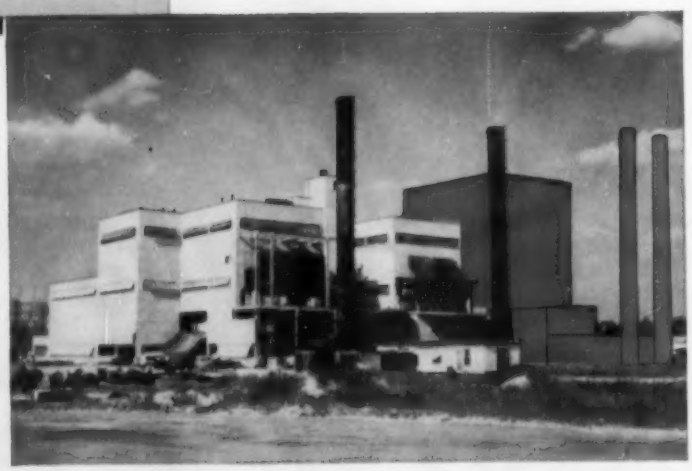
600,000 lbs/hr will more than at Florida Power

Suwanee

Riley Reheat Unit for Suwannee River plant will feature superheat and reheat steam temperature control without use of spray. Unit is designed to burn low grade oil, natural gas, with provisions for burning pulverized coal in future.

Feed Water Temp.	457 F.
Capacity	600,000 lbs/stm/hr
Superheat Pressure	1550 psig
Superheat Temperature	1000 F.
Reheat Pressure	450 psig
Reheat Temperature	1000 F.
Furnace Width	27′-3 15/16″
Furnace Depth	22′-7 5/8″
Heat Release in Furnace (oil)	
Btu per cu. ft. per hr.	22,800
Btu per sq. ft. per hr.	95,000

Black and Veatch
Consulting Engineers

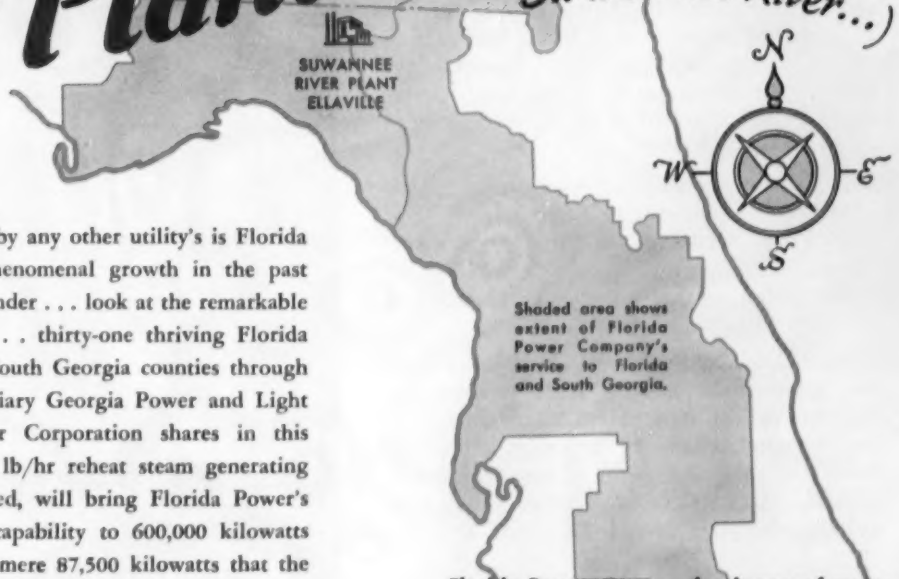


The Riley Unit, the largest of the three units at the Suwannee River Plant will more than double the kilowatt output. Construction will start soon and is scheduled for completion by end of 1956.

RILEY DESIGNS, MANUFACTURES AND INSTALLS COMPLETE STEAM GENERATING UNITS AND

RILEY Reheat Unit double Kw output Corporation's

River Plant... (way down upon the Su-wan-nee River...)



Almost unmatched by any other utility's is Florida Power Corporation's phenomenal growth in the past ten years . . . and no wonder . . . look at the remarkable growth area it serves . . . thirty-one thriving Florida counties, and nineteen South Georgia counties through its wholly-owned subsidiary Georgia Power and Light Company! Riley Stoker Corporation shares in this growth with a 600,000 lb/hr reheat steam generating unit, that, when installed, will bring Florida Power's net system generating capability to 600,000 kilowatts . . . a far cry from the mere 87,500 kilowatts that the company produced as recently as 1944.

Florida Power Corporation is one of many important public utilities that in recent years have ordered Riley Reheat Units . . .

Utah Power & Light Company
Gadsby Station
1-575,000 lbs/hr; 1700 psig; 1000/1000F.

Louisiana Power & Light Company
Nine Mile Point Station
1-1,000,000 lbs/hr; 1725 psig; 1005/1005F.

City of Los Angeles, Dept. of Water & Power, Valley Steam Plant
2-1,200,000 lbs/hr; 2075 psig; 1000/1000F.

Houston Lighting & Power Company
Deepwater Station
1-1,200,000 lbs/hr; 2125 psig; 1005/1005F.

Houston Lighting & Power Company
Sam Berton Steam-Electric Station
1-1,200,000 lbs/hr; 2125 psig; 1005/1005F.

Texas Electric Service Co.
Fort Worth
1-1,250,000 lbs/hr; 2125 psig; 1005/1005F.

Public Service Co. of Indiana, Inc.
Wabash River Station
1-805,000 lbs/hr; 2075 psig; 1005/1005F.

Central Louisiana Electric Company, Inc.
Teche Station
1-350,000 lbs/hr; 1050 psig; 1005/1005F.

Public Service Co. of Indiana, Inc.
New Albany Station
2-1,000,000 lbs/hr; 2075 psig; 1005/1005F.

Dairyland Power Cooperative
Alma, Wisconsin
1-390,000 lbs/hr; 1650 psig; 1005/1005F.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

RILEY
Stoker Corporation
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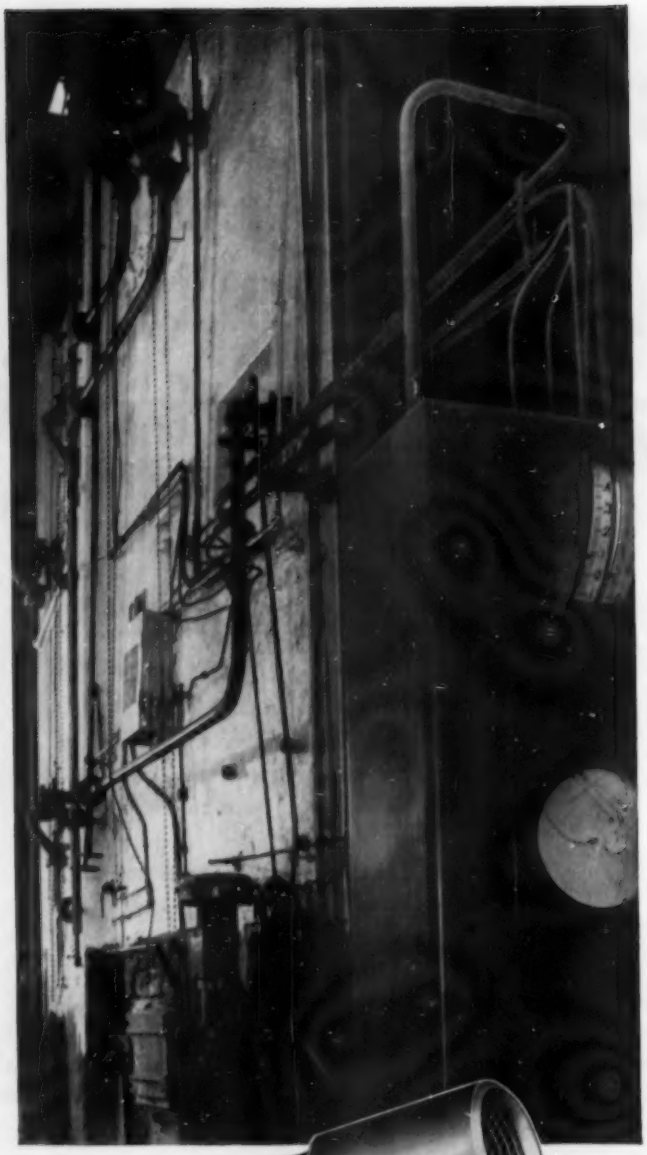
FUEL BURNING EQUIPMENT FOR PUBLIC UTILITY AND INDUSTRIAL POWER AND HEATING PLANTS

This YOLOY pipe has lasted 6 times longer



The pipe shown in the photograph of this large boiler carries steam for the "soot" and "fly ash" blower system in an Ohio electric plant. The service is so severe that regular carbon steel pipe had to be replaced as often as 60 days.

A solution for this corrosion problem was obtained by installing Yoloy pipe. Now, twelve months later, the Yoloy pipe is still in service—hasn't developed a single leak. It has lasted six times longer, and looks good for many months more.

Yoloy Continuous Weld Pipe is made from the same nickel-copper steel composition that has proved so successful in the oil, mining, railroad, chemical, trucking and other industries where resistance to corrosion and abrasion is of prime importance. It is now available in pipe sizes, from ½" to 4".

Get our booklet "The ABC of Yoloy Continuous Weld Pipe and its Corrosion Resistance". Write or phone the Youngstown District Sales Office near you.

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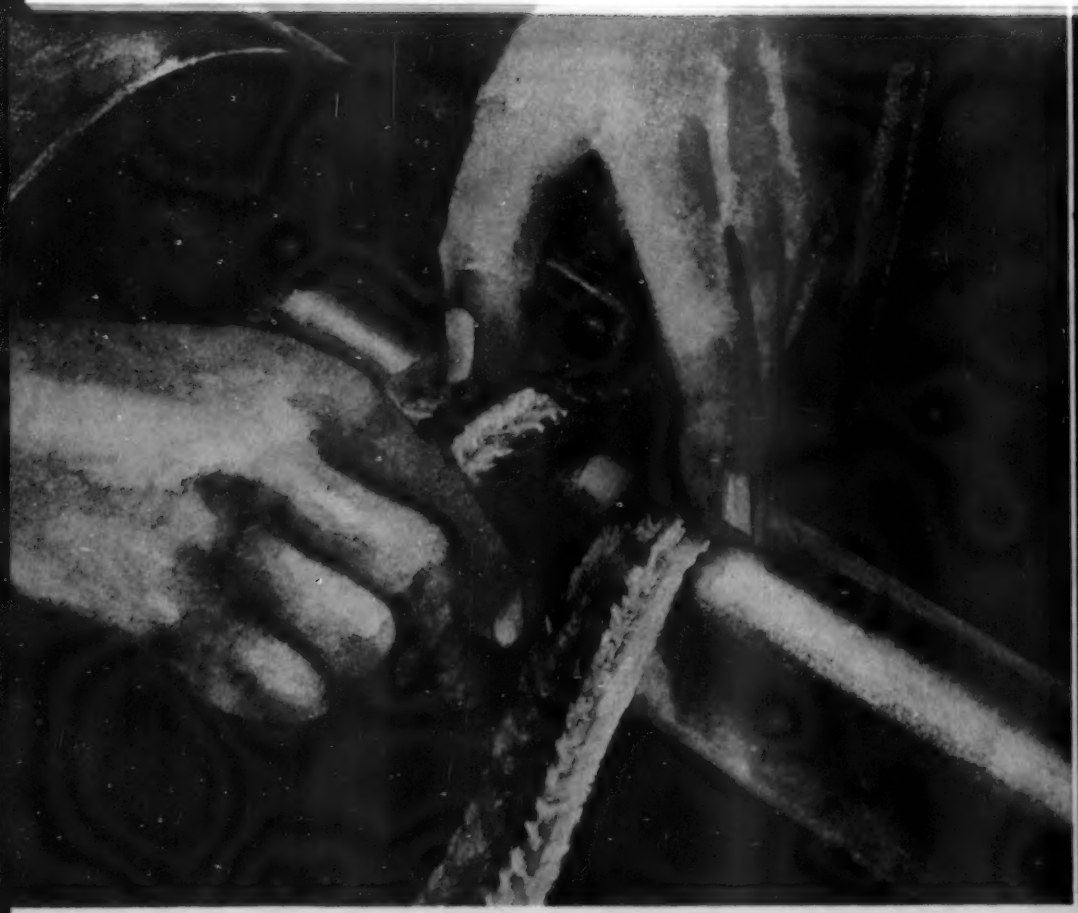
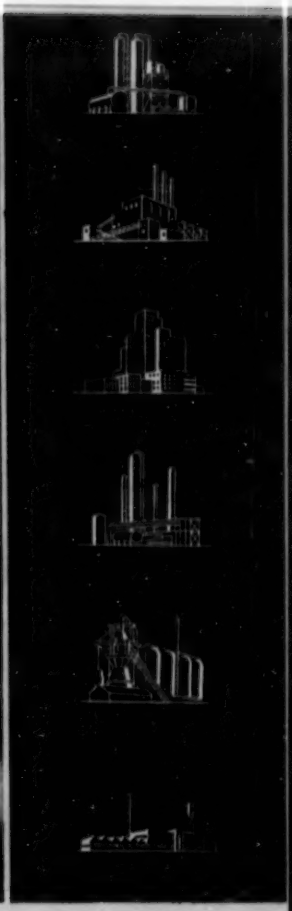




Here's *latest* on Mechanical PACKING*

By STEVE ELONKA, *Associate Editor*

The "man with the wrench" can be a dangerous person in your plant, responsible for scored rods, excessive down-time, wasted packing. The reason is simple: few operators really understand how packings work, especially "jam" types, forced against a wearing surface by gland nuts.

Nor are the men who design equipment and the men who buy packing for it always better informed. All too often the packing specialist is called in when design is complete and space dictates the seal to be used.

The plain truth is that packing isn't an exact science — there are too many variables. Experience is often the only answer.

To tap that experience for you, we went to the engineers and materials specialists of the packing makers, swapped facts with the big users of packing, visited research labs like the U.S. Naval Engineering Experiment Station, where packings have been tested for over 30 years.

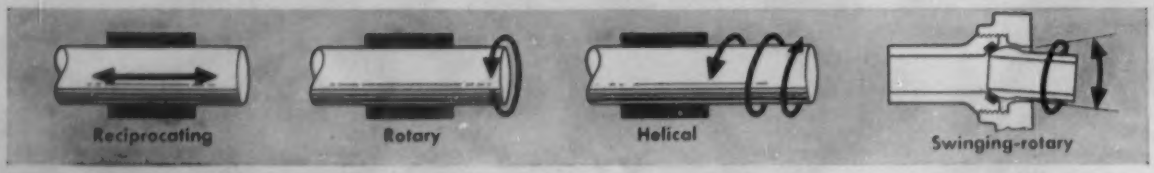
Here, boiled down and organized, is their know-how — packing basics never before told in print. Read it yourself. Don't let any man in your plant tighten a gland nut until he grasps the ideas explained here.

* PACKING is a dynamic seal, in contrast to a gasket, which is a static seal.

NOTE: To make your information on seals complete, get these reprints: PISTON RINGS (24 pp, July 1952) and GASKETS (20 pp, March 1954). And watch for a 1956 manual on MECHANICAL SEALS.

a **Power** practical manual

First: Let's see what motions we seal, what packing types we have for doing job



Four types of motion

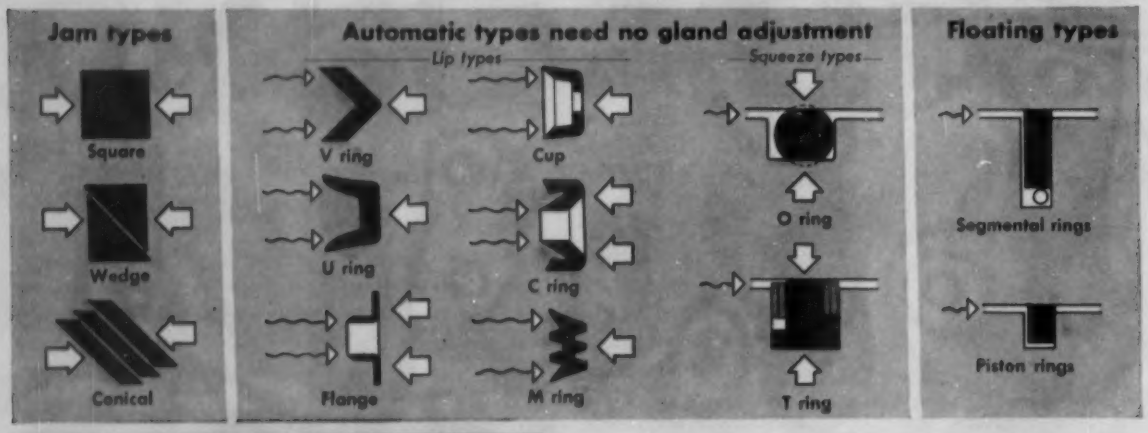
Sealing a static joint by clamping a gasket between surfaces isn't always easy, as we learned in *Gaskets*, March 1954. With thermal shock, pressure and chemical action all working on the sealing medium, gasket takes a beating.

Now packing must seal a *moving* part. If shaft is perfectly round with fine finish and running dead true, job is easier. But shafts usually run out at least a few thousandths. With grooves or shoulders on the shaft you have a really tough job, regardless of how good packing may be for licking problem.

Packing's job. When you try to seal by tightening packing to varying degrees with a wrench, you go against "good mechanics." Reason: Machine designer tries to reduce friction but packing acts as a brake on moving shaft.

Many operators don't know that packing in, say, a centrifugal or reciprocating pump must *throttle* leakage—not stop it altogether. That's because packing acts like a bearing and must be lubricated like one. Lubrication comes from slight leakage of fluid inside machine or, in emergencies, from a *saturant* in the packing. Where these aren't practical, packing must be lubricated some other way. Remember, if packing is dry it runs hot, hardens and scores the shaft—like any other bearing that fails.

Four motions are sealed by packing: (1) *reciprocating* (2) *rotary* (3) *helical* (as in a valve stem), and (4) *swinging* (as in a ball joint). Usually, packing seals against outward leakage, but where inside pressure is below atmospheric it must seal against air leaking inward and destroying the vacuum.



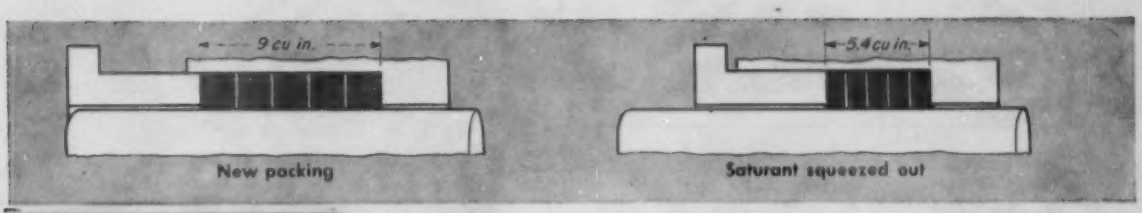
Here are packing classifications

Packings fall into three broad classes. First, there's the so-called "jam type," which includes any packing that is jammed into a stuffing box and adjusted from time to time by tightening nuts on a gland. These packings are braided, twisted, woven or laminated of rubber, leather, fiber, etc. As we'll see, other constructions and materials may be used.

Next come automatic types—so named because usually they need no gland adjustment. The fluid sealed supplies the needed pressure by forcing packing against wearing face. These packings can be further divided into lip and squeeze types. Better known among lip types are the cup, flange, U, etc. Best known of the squeeze types is the O ring. Here, interference is built into ring; it's thus squeezed into the groove. Fluid pressure holds it against wearing surface.

Third are the floating types. These include segmental rings of carbon, metal, plastic, etc, held around shaft or against cylinder by springs. Piston rings, with built-in tension, also fall into this group.

Now that we have a general idea of packing classes, let's see how jam types seal, what part packing volume plays.

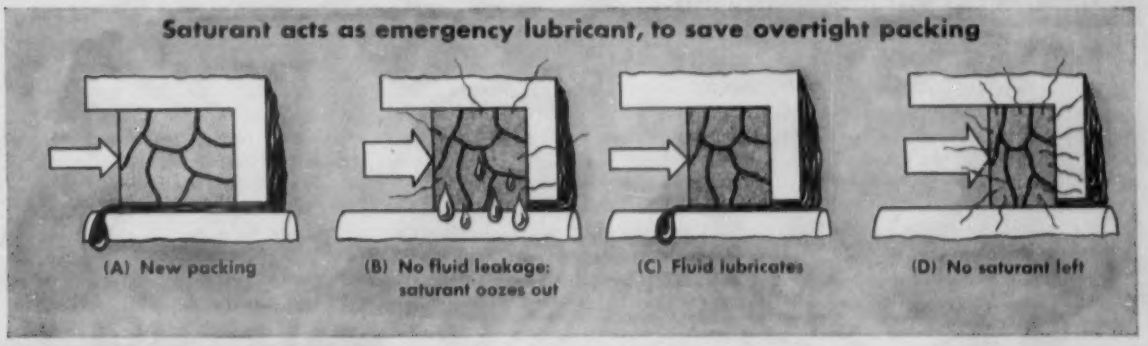


How packing seals

Volume taken in stuffing box by jam-type packing is key to understanding how this commonly used packing works. Manufacturers say packing is wasted, rods and shafts scored and packing needlessly burned up because few mechanics working daily with it understand this basic principle.

Left sketch shows a stuffing box filled with five rings of new packing. In this example, braided packing is saturated with lubricant, coated throughout with graphite and takes up about 9 cu in. of space in box. Here the gland nuts are only hand tight because the new packing was just installed.

Right-hand sketch shows same packing completely compressed until it takes only 5.4 cu in. Volume is less because all saturant has been melted, squeezed or washed out. Because packing can't be compressed further, it has reached end of its useful life. You must renew it or it will burn up and score the shaft, causing more damage than the cost of the most expensive packing. Let's read on and learn why packing has saturant, what happens when volume is reduced.


Saturant acts as emergency lubricant, to save overtight packing
(A) New packing
(B) No fluid leakage: saturant oozes out
(C) Fluid lubricates
(D) No saturant left

Packing fails like this

We told you, p 100, that packing acts like a bearing, needs lubrication as any other bearing does. Sketch *A* shows new packing, before gland has been tightened. As machine runs, some saturant in packing is washed or squeezed out. As saturant is lost, packing shrinks away from shaft because its volume has been reduced. Here operator usually tightens gland, stopping all fluid flow.

With no leakage, there is no lubrication from fluid flow. So rod heats up and temperature of packing goes up. That's when lubricant, placed inside packing material by manufacturer, goes to work, sketch *B*. High temperature starts to melt oil out of packing, which lubricates shaft for just such an emergency. Because more oil has oozed out of packing, space taken by it is again reduced. That starts flow of liquid from casing, which again lubricates rod and packing, also carrying away heat, sketch *C*.

But here is where trouble can start. If operator tightens gland enough to stop leakage again, liquid flow is lost. Again high temperature melts more packing lubricant, reducing volume and starting flow from casing automatically as before. This can go on until no saturant is left in packing, until packing's volume cannot be further reduced. When gland is next tightened to stop leakage, packing burns up and rod scores, sketch *D*.

This simple principle, once understood, will get the service from packing that is built into it. Every man given authority to tighten a packing gland, regardless of how unimportant the job may seem, must understand this or he will score rods, waste packing and cause untold damage in outage and maintenance bills.

Now that you know packing volume taken by lubricant is important, you might ask how much saturant a packing should have. The Navy does not accept a packing that contains more than 30% of saturant by weight. Usually it's much less in most braided or woven packings.

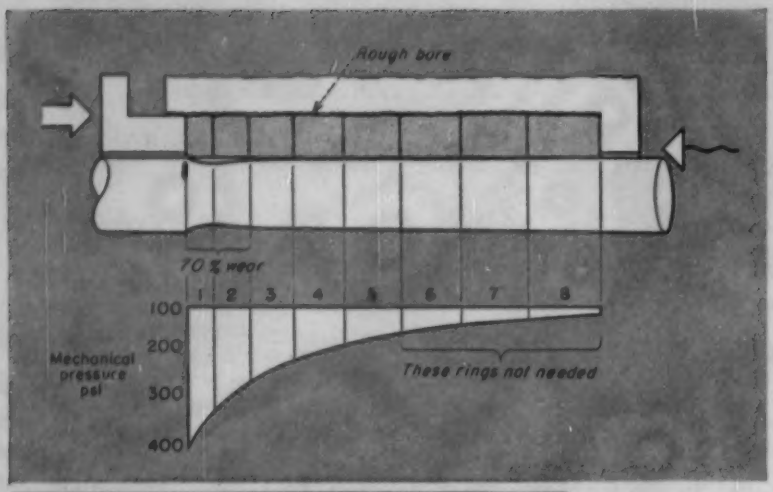
If you buy packing that's over-lubricated, excess lubricant washes out or is squeezed out after being in operation a short time. Then, because weight is taken up by excess saturant that does no good anyway, you have less fiber to seal joint.

How to tighten packing. Here's something to pound into the head of every operator. There is only *one* way to tighten a packing gland. If joint leaks too much, tighten each hexagon nut only *one* flat. This is one sixth of a turn. Then wait for about ten minutes. Reason: It may take that long for packing to adjust itself and reduce excessive leakage.

After ten minutes, packing has distributed itself in box and you can tighten nuts another flat if leakage is still too much.

Glands are usually tightened when machine is shut down overnight, to prevent leakage. But trouble is that operator starting machine next time does not loosen gland. This is common cause of packing failure and of grooved shafts. It will pay you to use a sign reading, "Loosen packing gland before starting this machine." Place sign on machine.

Turn page for more on how jam-type packings work



Ring next to gland works hardest

It's natural to ask which ring in a stuffing box does the most work. In typical jam-type packings, most sealing is done by the ring next to the gland. In all-metallic sets, to be described later, pressure drop across set is more uniform, but ring next to the casing breaks down most of the fluid pressure.

Reason. The mechanical pressure is higher at gland because friction on outside of packing against stuffing box is much greater than friction along the rod. This would be true even if bore had same fine finish as rod. If friction along bore were not greater, packing would revolve with shaft. Then it follows that the more rings the gland tries to force against the bottom of the box, the greater the pressure on the first ring it presses against.

Installing new packing. If a set of several rings of the same density isn't seated ring by ring, but all seating is done by the gland at the same time, rings nearest gland will be highly overloaded. Then, because of pressure decay, rings in the bottom of the box may do no sealing whatever.

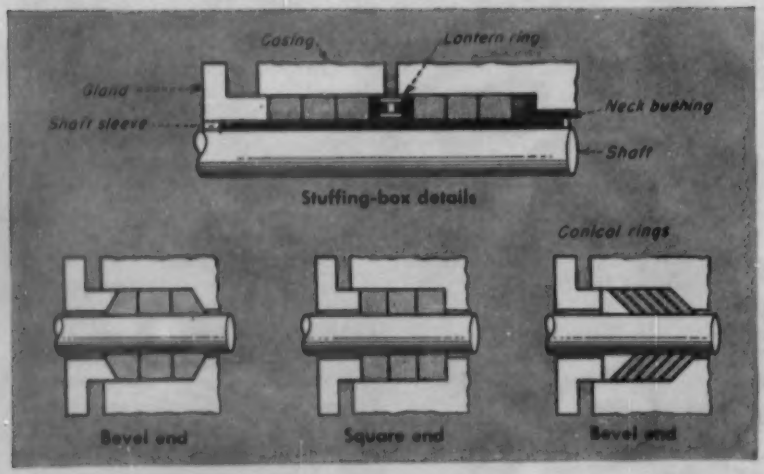
Where a combination set of soft and hard packing is used, softer rings in the set normally do most sealing. That's why dense rings must be seated correctly in the box—to keep fluid pressure and gland pressure from being exerted against softer rings, which would extrude through the joint opening.

Test results indicate that, on both centrifugal and reciprocating pumps, about 70% of wear is on first two packing rings nearest gland. Question, then, is why not have two rings only, or at most three, since they do most sealing. Reason is that each additional ring does throttle *some* fluid pressure. And on most machines there must be enough rings so if one fails another does the sealing and the machine needn't be shut down. That's one of the biggest advantages of packing compared with mechanical seals—mechanical seal does not seal against shaft, but has, for example, a perpendicular ring of carbon sealing against a steel ring.

How many rings? Curve shows eight packing rings. Only about five of these are needed, according to pressure curve, as bottom three do little sealing. Advantage of using fewer rings is less rod wear. And stuffing-box design is simpler, takes less material. If all packing rings did same amount of work, then it is quite logical to assume that five rings would wear rod five times as much as one ring.

But wear isn't the only problem. With high temperatures and high pressures, corrosive chemicals or abrasive particles in the fluid, more rings may be the only solution for some services. In such cases, the bottom ring contacting the casing fluid may take most of the beating from these severe service conditions.

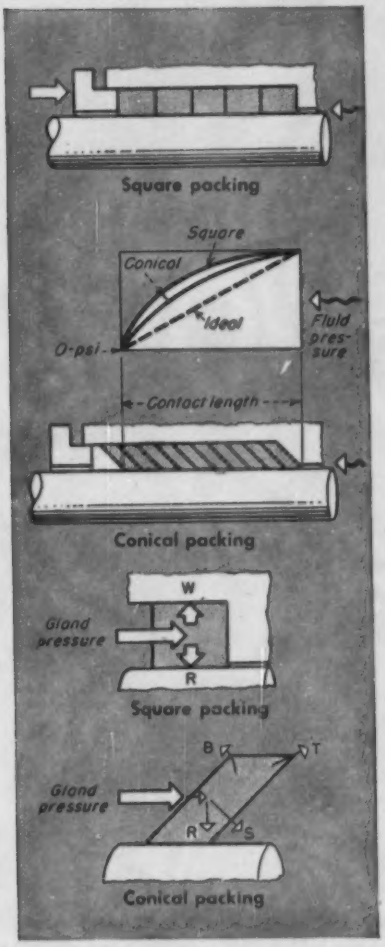
Some rings do more work than others—also,



Box and packing design

Packing material, shape and size, box design and clearances all affect sealing. Ideal packing would be one with low coefficient of friction, absence of abrasive effect upon rod, and capacity to prevent leakage. Since jam-type packings are used in stuffing boxes, let's see what effect box design has on sealing efficiency.

Standard stuffing box for jam-type packing in larger machines has neck bushing, lantern ring and sleeve around shaft, top sketch. Sleeve and neck bushing can be replaced when worn. Grooves in sleeve of rotary shaft are hard on



Effect of packing shape

What effect has packing shape? In the curve, left, we see how packing causes fluid pressure to drop along the rod. Here the fluid pressure is against right-hand face of packing set. Pressure at gland is zero (atmospheric). As shown by top pressure curve, square jam-type sets impregnated with saturant show a rapid drop rate near packing gland. That proves outer rings at gland do most sealing, first two rings near gland doing about 70%.

Chart shows that conical rings, center curve, have faster rate of drop, though rate is slower near gland than with square forms. Here curve is more uniform, each ring takes more even share of fluid pressure throttling. For ideal packing set, pressure drop should be straight (dotted line). Such a set would distribute friction evenly over entire contacting surface.

Square packing. In sketch next to bottom, the fluid pressure is against square braided packing that's saturated with a viscous fluid. Section is now in fluid compression (fibers being in tension), which resolves pressure equally in all directions—reactions *W* against bore and *R* against rod. When saturant is forced out or drains away, pressure ceases. Then to seal joint, mechanical force is needed, causing packing to become a contact-friction bearing, without elasticity that pressure-fluid assembly gave before.

Conical ring, bottom sketch, has cross section at angle with both stationary and moving surfaces. Here inside diameter of cone faces source of pressure. Thrust takes place when pressure drops, horizontal arrow shows thrust due to pressure difference. Pressure may be resolved into thrust *S*, perpendicular to the conical face and thrust *R* against rod. This force seals joint at expense of friction. Wall surface is sealed by wedge thrust *T*, driving outer ring edge against wall and adjacent surface. Result of various thrusts causes cone to attempt to occupy position of a radial disk, shown by arrow *B*.

Cone shape has tendency to seal a joint automatically while pressure is against it because there's a continual pressure drop through fibers or laminations. Curve shows how greater frictional efficiency of cone comes from better distribution of thrust in assembly.

Conical packings are very sensitive to width used. Experiments show that 45-deg cone gives low average friction through set. Various cross sections are used in packing, such as double-taper cone, curved cross section, etc. To get best results, understand theory in back of each design, then try to apply it to the right problem in the right way.

packing shape and stuffing-box design count

packing because packing must adjust itself to grooves every time it's tightened—or when machine is started and stopped and shaft expands or contracts. Neck bushing often wears at bottom as shaft bearings wear. Keeping clearance all around shaft and neck bushing even and at a minimum makes life easier for the packing.

Lantern ring is for forcing lubrication into packing set from outside source. Or, in some applications, it is for forcing clean fluid against abrasive fluid to save packing and shaft.

Beveled ends in stuffing box are often a question. Theory is that bevel tends to force packing against shaft where sealing is needed, giving better sealing with less gland adjustment. This may help some packings, but it also tends to extrude the end rings of soft packings, scoring rod and wearing packing quickly. Many packing makers are against bevels in boxes, say square ends are best.

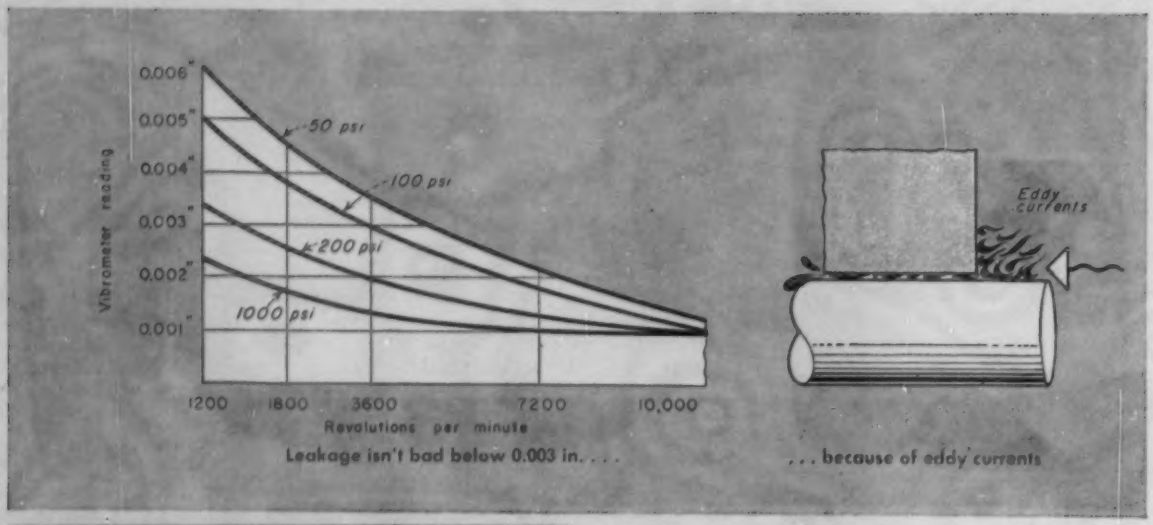
For so-called plastic (loose-fill) and metallic packing, use only square ends. Special conical rings do need beveled ends to conform to cone-shaped rings, but packing is designed for pinching effect between rod and housing.

Clearance at neck bushing and gland is important. Less space gives packing less chance to extrude, reduces friction against rod. Clearances often depend on machine's service and the fluid the packing must seal.

Shoulders on reciprocating rods are hard on packing, especially if neck bushing has excessive clearance. Rod then wedges into packing, tends to force packing out through clearance at end of each stroke. Shoulders on valve stems and rods are common cause of duplex-pump short stroking. With inertia-governor steam-engine generators, same thing causes lights to flicker.

All this means that before we can expect packing to do a job, condition of stuffing box, rod and clearances around the rod are mighty important.

For tips on packing's enemies, turn page



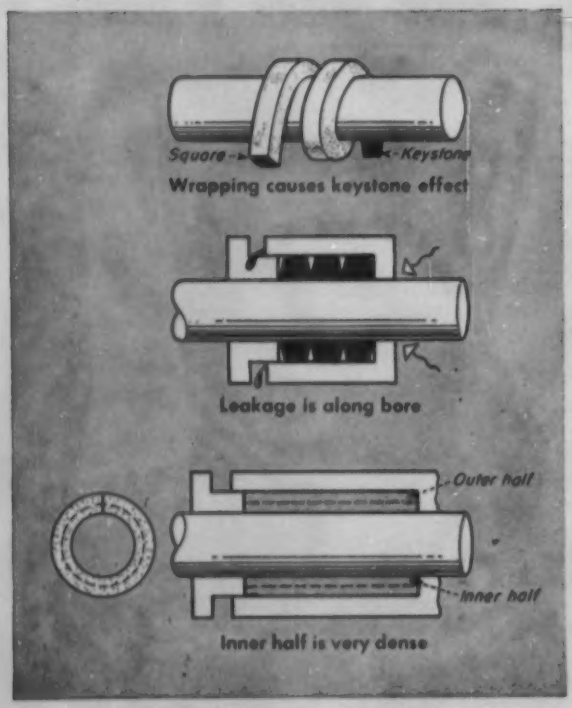
Gyrating shaft is hard on packing

Friction and fluid pressure are always present, but there are other forces taking pot shots at your packing: (1) gyration, when shaft runs out of true center (2) abrasion (3) chemical action (4) temperature (5) erosion (6) galvanic action. Let's look at them.

A common fault in rotary equipment is a shaft that's bent, or flexes at high rpm. Tests show that even when a pump shaft, for example, is accurately machined, assembled and balanced statically and dynamically, it vibrates to some degree at high speed.

A gyrating shaft whips around in the

Among foes swinging to knock out packing:



Keystone effect may cause trouble

When jam-type packing with square cross section, sketch, left, top, is wrapped around shaft, cross section has tendency to assume shape of keystone. Smaller shafts and larger packing cross sections give greater difference in inside and outside diameters, causing greater keystone effect.

This effect compresses packing on inside diameter and expands packing on outside. When gland is tightened, packing rings are squeezed together until sides are vertical. Now we have packing rings very dense on inside diameter against shaft, rather loose against stuffing-box bore on outside.

Difference in volume. Bottom sketch shows stuffing box with total volume in packing space of 16.75 cu in. Volume in inner half of this space is 7.37, outer half is 9.37 cu in. So inner half has 2 cu in. more material compressed into it than outer half.

This condition can cause leakage over outside of packing. Then leakage is usually from gland OD, not along shaft. In such cases, tightening gland to stop leakage burns up packing because there's no fluid flow along shaft to start with.

Keystone effect is not common on modern machines, but there are many older machines in use where stuffing boxes may be poorly designed. Bore OD can be reduced on such jobs by pressing a liner into the stuffing box to give you the proper packing size. Or use a loose-fill (plastic) packing here.

stuffing box, forcing larger opening between packing and rods. Same effect appears when a reciprocating shaft has shoulders—they keep wedging packing open with each double stroke.

How gyration hurts. To see what punishment packing takes from a gyrating shaft, take a pump with a 50-lb impeller running at 3600 rpm. At this speed, let's say the shaft has a whip or gyrating effect of 0.003 in. That means it opens the packing 0.003 in. on a side, or 0.006 in. all around.

Now a 50-lb impeller at 3600 rpm exerts a centrifugal force of 702 lb if shaft gyrates a total of 0.006 in. And this force comes in blows 3600 times per minute against the packing. So regardless of how resilient the packing is, it'll have a tough time hugging the shaft under such punishment. And if fluid pressure inside casing is 50 psi, for example, that pressure working on the packing is unimportant compared with the 702-lb wallops.

How much vibration? Chart, *left*, shows vibrometer readings that flexible stuffing-box packings have a fair chance to seal against, depending on rpm and fluid pressure. By tracing the 50-psi curve to 3600 rpm (*vertical line*) we find the total shaft gyration our packing can cope with is about 0.003 in. That's half what pump in this example has. So solution here is not renewing or trying different packing, but first getting shaft to run within allowance. That means straightening shaft if bent, or balancing pump shaft and rotor assembly dynamically, or overhauling pump bearings. But not until this shaft runs within the limits shown will you start solving the packing problem.

Reason that most packings seal fairly well against slight shaft clearance shown on chart (depending on fluid pressure and rpm) is that the turbulence of fluid slows leakage at slight clearances.

With a little practice you can hold a pencil point against a revolving shaft and tell if it runs out over 0.003 in. Before condemning a packing or trying any other remedy, always check shaft gyration at top speed. Reason packing on slow-moving reciprocating rod seals better against bent shaft than on fast revolving shaft is that packing has time to spring back against shaft.

Abrasion. When fine grit particles reach packing, they imbed, cutting the shaft. Grit can be pipe scale, chemicals in suspension, etc. For example, when hot water evaporates through gland, solids are left.

Chemical action. This comes from chemical solutions under pressure causing abrasion. Then wearing surface of packing gets clogged by products of this action, stiffens, leaks more.

High temperature volatilizes lubricant in packing, hardens material. In asbestos, when temperature goes above 900 F, water of crystallization is reduced, asbestos turns to powder. Solution is to keep packing lubricated and cooled, or use metal packing to withstand the high temperature.

Galvanic action. If packing is saturated with an electrolyte, galvanic action does its dirty work while shaft is at rest. Many fluids have slight electrolytic action. Minute wandering currents remove metal of shaft. Look for irregular deep pitting at various points. Galvanic action is caused by different metals, carbon and other conducting materials in the machine. Carbon, though greatest cause of galvanic action, isn't usually affected. Grounding shaft against carbon brush is an answer.

shaft gyration, abrasion, high temperatures

Chrome plating is one way to reduce shaft and packing wear

Abrasive wear and some types of corrosion are fought today by coating shafts, rods and valve stems with dense chrome. Typical tough service for both packing and shaft is in steel-mill gas compressors, where dry, dirty gas causes heavy abrasive wear.

Dense chrome of 1000 Brinell is electrodeposited on shafts. This gives as much as 4 to 10 times longer life. Packing also wears as much as 4 times longer in some cases. By comparison, most shaft and rod metals are 200 to 450 Brinell. Hardened tool steel is 650, and most machinist's files are 750 Brinell.

Chrome has virtually no ductility or elongation so it must be coated on a clean, solid surface. Before plating, shaft is ground undersize for required thickness of chrome. Finish should be under 10 micro-inches. (A micro-inch is one millionth of an inch.) Unless shaft finish is right, chrome plating will be rough. That means more finishing on hard chrome, which is costlier than finishing the softer shaft.

Thickness of coating for contact surface under packing depends on shaft size and service, ranges from 0.006 to 0.030 in. on the radius. About 50 to 100% more chrome must be added for finishing. Coating is then ground to finish of less than 10 micro-inches. Some shafts are finishes to about 2 micro-inches, known as a *superfinish*, in lapping machines.

Galvanic action. Chromium has good corrosion resistance and if galvanic action is present, chrome is not likely to be etched. For example, magnesium is least *noble* of metals—is most likely to be attacked galvanically. Chromium is one of the most noble metals.

Sprayed metals. Shafts or shaft sleeves are also built up with sprayed metal where wear takes place through stuffing box. Usually a hard stainless steel is used. Because of tiny pores in sprayed metal, oil is retained. This can prolong shaft and packing life, especially where no abrasive grit is present.

One advantage of spraying is that work can be done in shop, often without removing large shaft from machine. Shaft is usually rough-turned for anchoring sprayed metal. Then it is built up to at least 0.010 in. oversize for finishing by grinding with fine wheel.

Second: Let's learn how packings are made and why, starting with familiar jam types

Twisted and braided

One of the simplest packings is twisted fibers, often used for small valve stems. Advantage of this construction lies in its flexibility. One size of packing can be used for various sizes of stuffing boxes. Twist is quickly undone and mechanic can twist his own size by using the number of lubricated and graphited strands he needs for a smaller space.

Braided type has about widest all-round use, comes in cotton, asbestos, rayon, nylon, flax, jute, ramie, Teflon, copper, glass, aluminum, lead, monel and other materials. Three braids are: Square, braid-over-braid, and interlocking.

Square braid has each strand passing over and under other strands that run in same direction. No strand passes entirely through packing. Because no single strand links with all others, strands are free to move, can adjust to uneven rod motion, especially when internal lubrication is thorough.

Braid-over-braid is a series of braided tubes, one over the other. Each tube is separate, with the smaller one braided over a core. Shape of this packing is naturally round, but is often calendered square. A dense packing, it's used where shaft is in good condition, for severe pressure jobs.

Interlocking braid. Every braiding strand passes diagonally through body of packing, at angle of about 45 deg. This makes a completely unified structure, braided internally and externally. Every strand contributes to strength of entire mass. Advantage is that wear does not loosen strands. Large packing sizes deform less when formed into rings.

Binders for most of these types are natural or synthetic rubber, mineral or fatty oils, wax, white petrolatum, castor oil, shellac. Others have chlorinated or fluorinated lubricants, high-flash mineral oil, glycerin, soap or mixtures.

Choose braided materials according to fluids handled, then consider service. Jute, cotton, rayon, flax or ramie are common for water. Flax and ramie hold up on reciprocating rods against water because long, strong fibers have wet strength.

White asbestos is usually good with alkaline, neutral or weak acid solutions. Asbestos serves for both reciprocating and rotary shafts. About 20% cotton fiber is mixed with white asbestos for weaving. Blue asbestos is all asbestos, resists strong mineral acids. It is a coarser, more irregular material and wears shaft more. Because fluid leakage is not wanted with acid, it's best to use lantern ring.

Metal braids are tough, but lubrication must be good and shaft must run true as metal has no resiliency—cannot handle shaft whip or gyration. Wire is often inserted in fiber to increase strength. Metals may be only solution for high-temperature. Some metals wear shafts less than some fiber packings do.

Plastic braid of Teflon shows many times life of other materials in highly corrosive fluids. Because of high coefficient of expansion, watch it as temperature climbs. Made into a suspensoid, Teflon is now used to saturate both blue and white asbestos, for increased life against water, acids.

Woven fiber

Woven fiber is wrapped, accordion-folded or laminated. Fibers are woven into cloth, reinforced with cotton, brass or monel wire. Because woven material is porous (so is braided type), material is often impregnated with rubber or compounds.

Wrapped cloth is usually cemented with binder to seal porosity and hold folds together. Accordion fold is another type, laminated is a third used in packings. There are various advantages claimed for each. These folded packings are easily formed into round, square or other shapes shown.

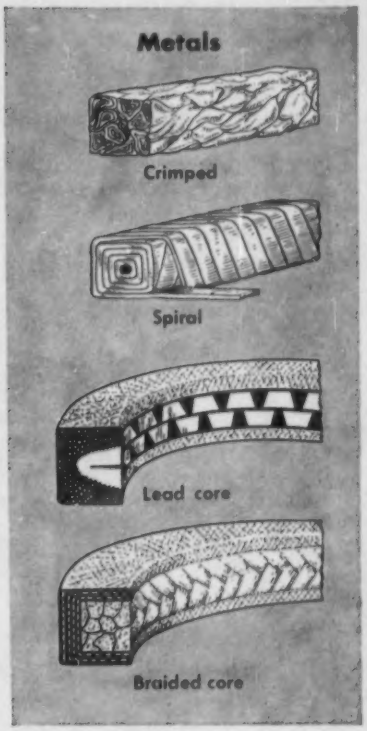
Ring packings of alternate plies of rubber and fabric are cut, spiraled or coiled from slab. Rubber acts as close conforming bearing and gives resilience, while fabric acts as lubricant reservoir. Fabric also provides voids for thermal expansion of rubber. Reservoir and presence of voids create an ideal combination when used on the right jobs.

When starting machine cold, packing seals shaft. That causes friction and packing gets hot. This heat thins lubricant, easing load. But heat also expands rubber, which has thermal expansion many times that of steel. That causes packing to tighten on shaft, thus increasing load—and heat. This could go on and on, but fabric plies compress, giving rubber some place to go, and squeezing more oil onto shaft, where needed.

Where temperatures are lower, as on reciprocating rods, a balance is soon reached. But rotating shafts might shoot packing temperatures way up. Don't use laminated packing on rotating shafts, unless speed is slow, not much heat.

Slab or plied-up rings are cut or sectioned at various angles to shaft to produce beveled or diagonal rings. They adjust themselves more easily under light gland loads. Special slabs also come with plies at an angle to shaft, for easier adjustment.

Male and female rings of this material are made in two parts, with joints staggered. These 2-piece rings are semi-automatic in action and operate with light gland pressure. Usually installed in combination with plain-cut rings.



Crimped and spiral-wound metal

Metals are crimped, spiral wound and braided. Some stand higher temperatures than fibers, have less friction against moving surfaces. Crimped packing is made of continuous thin ribbons of foil (babbitt, aluminum, copper, etc) spirally and loosely wrapped, crinkled and folded, then squared to needed size. Each layer of foil is lubricated with oil, graphite, etc, so voids form lubrication reservoirs, which is so important in a packing.

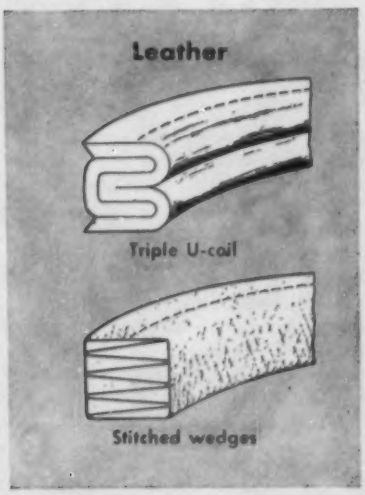
Spiral-wound flexible all-metallic packing is made by spirally wrapping thin ribbons of soft metallic foil, layer-over-layer construction, which is then squared. Each layer is lubricated with oil and graphite. In this way packing forms a lubricated metallic bearing and also provides a seal.

Metal-foil packings are durable, but not resilient. Here shaft must run fairly true, lubrication is important. Some have open construction of crumpled foil, well saturated with lubricant. Or individual strands of lubricated yarn are twisted with foil for some services.

Others have core of resilient, lubricated fibers, wound with foil cover. Main advantage of each is that metal foil makes excellent bearing.

Asbestos channel with lead core is old standby. Here lead expands and forms tight seal, while fabric is resilient, retains saturant. In use lead forms wearing surface against shaft, reduces friction. Channel type also comes with braided copper core, other metals.

Metallic-packing theory is to form bearing dense enough to support shaft loads, like a regular bearing. Because of capillary and molecular properties of fluids, oil will support a load equal to 800 psi on bearing area. Metallic packing must also be flexible, compressible, have little friction. Friction with these packings is mostly fluid film. Whether liquid film is material being pumped or applied through lantern gland, there is less wear than from fibers. For high temperatures, metals are often only answer to your problem.



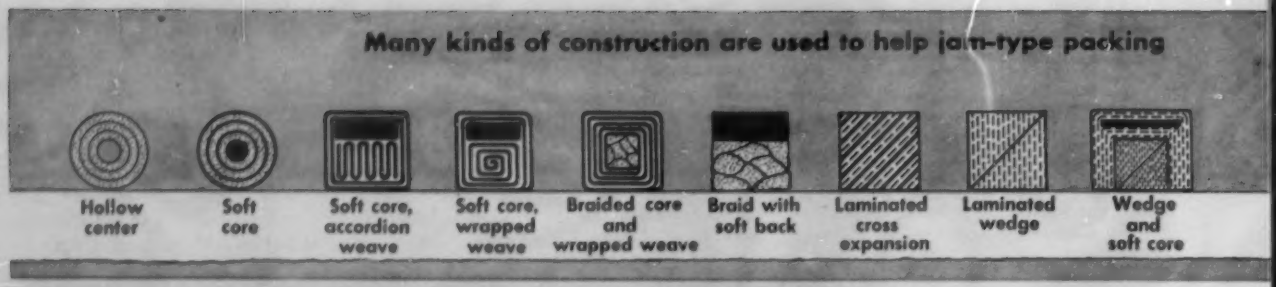
Leather has its place

Leather is one of the oldest sealing materials. It's a natural product of interwoven fibers forming a fabric that's pliable, tough, and highly resistant to abrasion and wear.

Leather is folded and wedged, made from preformed, interfitting shapes of pliable chrome-tanned skins, held together with linen-thread stitching. Wet leather has very low coefficient of friction. Parallel sides move freely under internal pressure to seal ram and stuffing-box wall. Use up to 170 F, for low to high pressures, with water and oil, on presses, accumulators, agitator shafts, and other hard-working equipment.

Packing—made of opposing wedges of tallow-impregnated oil-tanned leather, bound with linen-thread stitching, encased in braided-cotton jacket—combines long-wearing properties of leather with low coefficient of friction.

Use up to 175 F for general service, such as cold or lukewarm water, on reciprocating or rotary equipment: piston rods, plungers, rams, pumps, accumulators, presses, large rotary pumps, hydro-turbine shafts, turbines, piston rods and piston heads of magazine and pocket-type pulp grinders. Works well with end rings of braided copper on high-pressure plunger pumps.


Many kinds of construction are used to help jam-type packing
Hollow center
Soft core
Soft core, accordion weave
Soft core, wrapped weave
Braided core and wrapped weave
Braid with soft back
Laminated cross expansion
Laminated wedge
Wedge and soft core

Designs vary for solving sealing-lubricating problems

The more easily a packing moves against shaft when tightened, the easier it is to control leakage with gland.

Hollow center placed in stiff fabric helps packing compress and expand. Soft rubber core provides another way to give packing life, but high temperatures harden rubber. Soft core placed above accordion-weave is away from heat, lasts longer, or is placed in woven cloth or wrapped constructon.

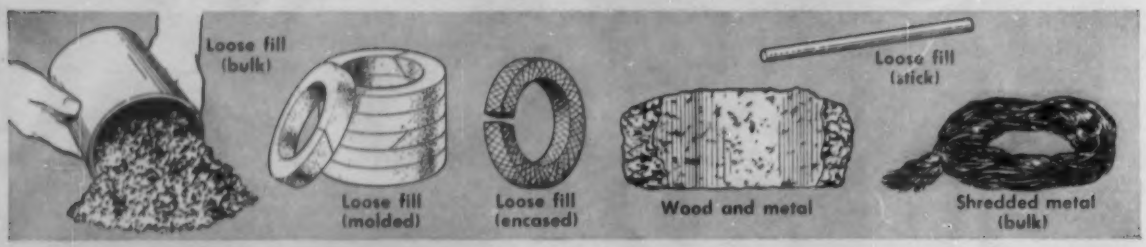
Square braid as core is placed inside wrapped weave. Rubber back is often combined with square braid as shown.

Cross-expansion type made of laminated material has more lateral movement than same material placed with grain at 90 deg to shaft, for example. But when turn of packing is made of two pieces of laminated packing to form wedge principle, outer half wedges inner half against rod to do sealing.

Core-and-wedge construction gives still more lateral movement. Combination of full turn of braid-over-braid packing with full turn of wedge-cut laminated material usually is more resilient than laminated type alone. Laminated material gives more stiffness than braid with core alone.

Lead-covered asbestos of square braid makes a flexible metallic packing. Lead foil is wrapped around asbestos yarn or

Some packing constructions have more give



Loose-fill (plastic*) is popular

Two basic-type loose-fill packings are: (1) mostly loose asbestos fiber (2) separate pellets, shreds or particles of lead. Both are called *plastic* because ingredients aren't bonded and packing mass deforms easily to rod's shape.* They come in bulk, stiff bonded rings, sticks, coils or spiral.

Packing mostly of asbestos fiber is for high temperature or where hardening or disintegration of bonding is objectionable. Unlike asbestos-cloth packings, they have no cotton—have large quantity of flake graphite, powdered mica, etc.

Metallic types are mostly pure lead, have low chemical resistance and low frictional properties. Don't use on soft brass or bronze under 450 Brinell as lead sticks to rods.

Shredded or pellet-form has space for flake graphite, asbestos fiber or high-temperature grease. Separating effect of these pockets retards matting and reduces friction.

Wood-and-metal type is diamond-shaped redwood and metal, or white-pine bits and equal parts of lead. Wood is saturated with lubricant, mixed with graphite. When tightened into a stuffing box, mass becomes compressed into ring. Metal does most of sealing and wood or asbestos retains saturant. Some materials are held together with a light braid over outside, acting like a sausage skin. Others have a heavy braid over a dense material to minimize porosity in solid braid. Here, instead of stuffing a loose material into stuffing box, casing holds material together for easy handling.

For best results, shaft should run true, have no shoulders. Seal clearance at ends of joint with turn of braided packing to prevent extrusion—unless clearance is very small.

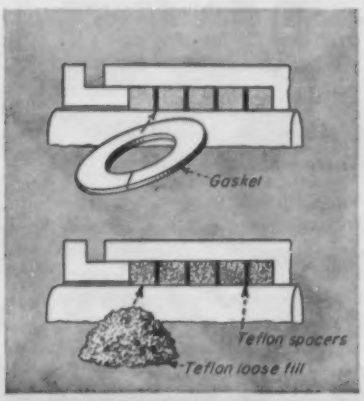
Shredded Teflon is also made into fine particles of loose-fill packing. It's excellent against strong concentrated acids—sulfuric, chromic, nitric and hydrofluoric—and all alkaline solutions. Can be used without binder against fluorine, chlorine, bromine, sulfuric, chloride, hydrogen fluoride, oxygen and concentrated hydrogen peroxide. But watch those high shaft speeds with Teflon, or packing will seize and burn up.

*This refers to packing construction type, not to the material used.

rope, and braided. Here asbestos provides the give and saturant, while lead foil does sealing.

There are many other types. Usually packings that are more resilient are best for rods or shafts that run out, or that have shoulders and grooves, or that cannot be shut down for major repairs. Then to stop excessive leakage, pack stuffing box with packing that will seal under emergency conditions.

built into them

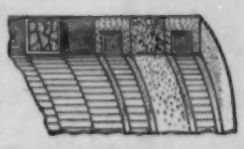


Gaskets and packing

Gaskets between packing act as barriers or dams, prevent fluids leaking through it. Gaskets must fit shaft, box bore accurately, with gasket joints staggered. Each gasket must also be forced against each ring carefully so they do not foul in box. Comes in asbestos or Teflon, attached to packing, for reciprocating rods and rotary work against cold water, volatiles like gasoline, benzine, naphtha, carbon tetrachloride, butane, propane and corrosive chemicals.

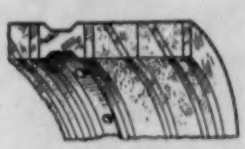
Combining packings for results

Now that we know most major jam-type packings, let's see why they're used in sets. Here two rings are all-metallic of spirally-wrapped babbitt foil. One ring is dry-braided asbestos with crinkled babbitt foil. Three semi-metallic rings have metallic wearing faces. One ring is loose-fill of asbestos, soft-metal particles and graphite. Use for high pressures of naphtha, lighter hydrocarbons to 450 F on reciprocating plungers or rods.

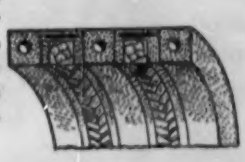


Here five leather wedge rings are between end rings of braided copper, acting as neck bushings for large clearances or high pressures. Replace copper rings with laminated fabric when piston rods are brass or bronze. This set is ideal for cold or lukewarm water in high-pressure triplex pumps, hydraulic presses, accumulators.

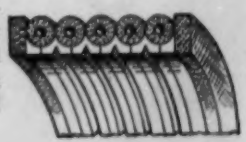
These diagonal-shaped rings are molded from shredded composition lead foil, bonded with compound and graphite. Babbitt separator rings between composition rings improve sliding wedge-action, act as fluid dams. Lantern ring is for external lubrication. Use on rotary compressors. For Freon, ammonia, carbon dioxide, other gases.



Three duck-and-rubber hollow-center rings and two rings of braided flax, covered on three sides with rubber and duck channel. Rubber and duck act as wiper, also protect flax. For hydraulic service from low pressure to extreme heavy duty, hot or cold water. This set adjusts well to out-of-line rods. Flax is flexible, retains lubricant in the set and helps do an efficient job.

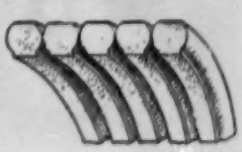


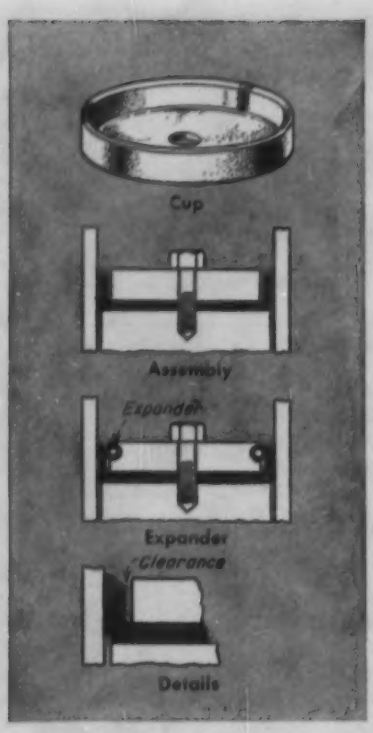
Here metallic rings have flexible fiber backing-rings. Laminated duck-and-rubber end rings keep metal from extruding while backing-rings give metal needed resiliency. This makes a low-friction rod packing set that adjusts to rod with little gland pressure. Metal is molded to shaft size and grooved to hold lubricant or fluid being sealed. For ammonia, Freon, CO_2, steam, air, gases and various liquids, where temperatures aren't high.



Soft metallic L-shaped rings fit inside waterproof hydraulic flax rings. Flax carries saturant, provides resiliency. Hollow-center end rings of wrapped fabric and rubber act as expansion-compression joint. By pulling up on gland when rod is cold, hollow-center ring stops leakage. When rod warms, hole takes up expansion, reduces friction. For rotary ammonia compressors. Lantern ring is often used in sets for best results.

Molded rubber rings with curved sides provide give while grooves between rings hold fluid as lubricant. Rings are split, compounded for up to 2500 psi and 250 F. Now used mostly for very severe service in slush-pump stuffing boxes, but should have various other uses.





Cups seal against cylinder walls

Up to now, we've discussed nonautomatic packings where "the man with wrench" controls leakage. But automatic types do a big job, usually need no adjustment. They seal from low of 75 to 80,000 psi, are called automatic because fluid pressure actuates, adjusts or establishes operating clearance. Result is finer operation with less leakage—also higher packing loads and reduced friction on return stroke.

Reciprocating rods, rams and pistons often weave and pistons slap because of nonrigid supports. It's here that flexible, pressure-actuated packing does good job. But reciprocating movement helps heat dissipate by exposing rod with each stroke. Rotating shafts give us a heat-removal problem, even where cooling liquid is forced through lantern rings. So automatic packings are used here only for low speeds, pressures and temperatures.

Cup packing, one of oldest in this group, has pressure gradient along side wall or lip. Inside of cup has full fluid pressure, with maximum at lip, decreasing to zero at base. Cylinder wall supports pressure at cup's top. Less support comes from wall nearing heel, until cup carries full load where heel bridges gap.

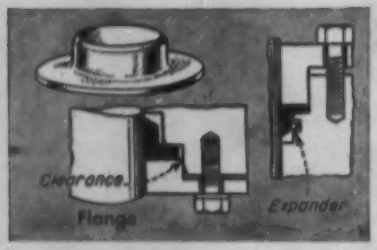
To insure tip contact and heel clearance, cup has outward flare. For low pressures and shock loads, an expander (such as a spring) is placed around inside of lip to force it against cylinder. If lip loses contact, leakage past cup can be very heavy.

Heel clearance is needed so full pressure is not carried by this narrow area or it wears excessively. Keep clearance between piston and cylinder small to prevent extrusion at cup's heel. Make sure piston is properly supported so cup has only one job—to seal.

Cups are leather, Teflon, synthetic rubbers—often fabric-reinforced.

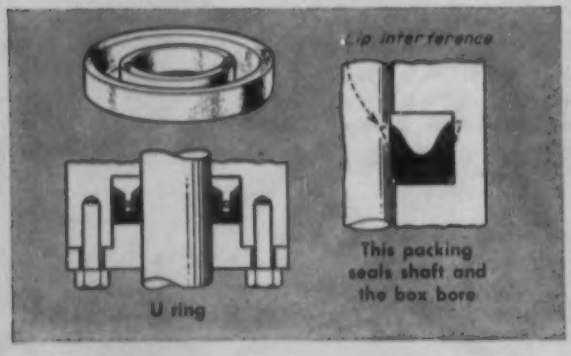
Leather is also saturated with rubber for longer life or flexibility. Used mostly on pistons, plungers or rams for sealing reciprocating motion. Cups are both a dynamic and a static seal.

'Automatic' packings breathe with pressure



Flange packings are for shafts

Flange packings are really inverted cups—same rules hold for them as for cup types. They are used on shaft or plunger instead of in a cylinder. Flange types are usually for small cross-sectional widths where a U or V type isn't practical. Flange area forms a gasket or static seal when follower is tightened on base of packing. Inside surface or lip of flange thus forms a mechanical packing seal against piston rod or shaft. For either reciprocating or rotary motion; comes in same materials as cups. Small space needed is big advantage of this packing.



U ring seals cylinder and shaft

U type is combination of cup and flange designs. U is pressure driven not only against the mating moving-face, but also against the supporting walls of its recess. This does away with mechanical retention by bolts or retaining plates as only positioning pedestal is needed.

Internal pressure to be sealed acts equally in all directions over entire inner surface. Because pressure cannot escape, packing is statically balanced and securely held.

Main advantage lies in flexible lips, which allow interference built into packing to be great, without increasing initial stress or friction. That means harder material can

Other automatic and semiautomatic types

Sketches show semiautomatic lip-type packings made by many manufacturers. Designs all indicate some adjustment is needed, depending on sealing sensitivity required. Certain special sealing features are provided by other makers, described in detail in their literature. All designs need header and follower rings as support and actuating elements. Spring-loading devices are also recommended by specific manufacturers for continuous and equal adjustment forces at all times, thus doing away with adjusting the gland manually.

V rings are similar to design, but there are more rings in stuffing box. Advantages are: sturdy construction; gradual pressure breakdown; more sealing edges; rings can be cut (stagger joints); gland can be packed without tearing down machine; because they nest, spreading action follows through set; different materials can be used in same set for unusual conditions (soft ring next to pressure initiates seal—hard, rugged ring carries most load across clearance); less danger of shutdown as next ring takes over if one of the rings fails.

Materials used are leather, various rubbers, composition and fabric, Teflon, resin impregnates, etc. Homogeneous rubber does not have extrusion resistance for high clearances—use reinforced materials here. Lip rings are mostly for reciprocating motion—also for rotary. Install either as a piston seal (inside packed), or in stuffing box (outside packed). Design details vary, see sketches, but fall in two general groups: rings that (1) contact each other on both sides of V (2) have clearance under lips for fluid reservoir.

Above 3000 psi, metal separators prevent distortion. Because entire fluid load is from bottom against top female-adapter, top rings carry most load, fail first. For extreme pressures, use top female adapter of metal to prevent rings under it deforming.

Tapered lips insure initial interference and immediate sealing. Male adapter at bottom is grooved and drilled to conduct pressure to lips of succeeding V ring. That insures automatic lip action and a positive seal under pressure. Ports in top also help equalize pressure on both sides of ring.

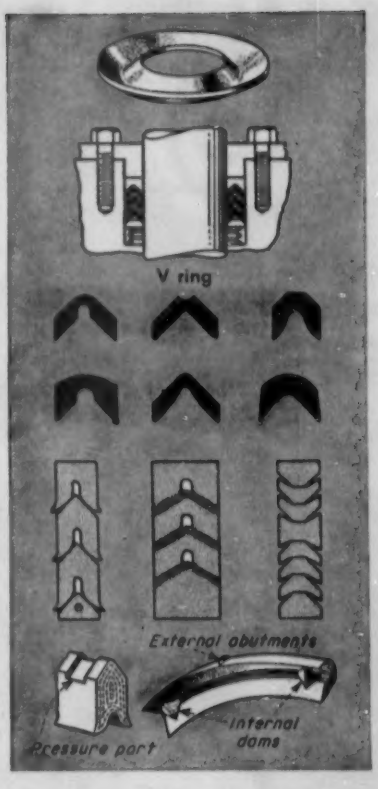
Cut joint is weakest part of any ring. Dams around ring's bottom are intended to keep fluid from leaking into cut ends, then around space on ring's top. Nonadjustable spring-loaded glands are also used to assure uniform breakout friction, lower running friction, even and predictable packing life.

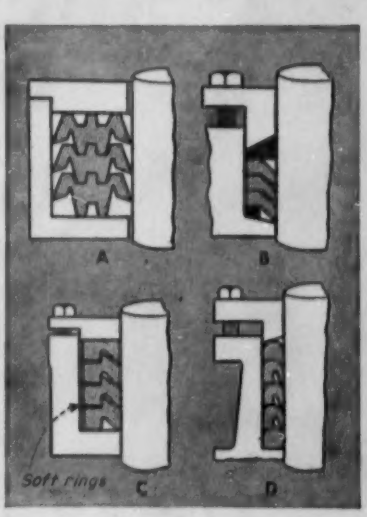
M type, packing *A*, is really a U type with built-in load-bearing pedestal under each ring, allowing each to act as a unit automatic lip-sealing ring. Gland pressure isn't needed, as sealing depends on materials in packing and pressures. Followers prevent distortion of support elements in rings.

Packing *B* combines features of low friction contact with rod and sealing action against entire stuffing-box area. Gland pressure seats packing firmly in stuffing box without increasing friction between moving parts. This is combination lip and solid packing, with solid part taking gland pressure, leaving flexible lips free to seal.

Packing *C* combines positive, nonyielding properties of solid packing with automatic sealing of lip ring. Soft rubber cushion between rings squeezes against rough wall of stuffing box, stops leakage. Square section absorbs gland pressure (gland can be very tight), without transferring unneeded pressure to rod. Packing can't roll or ride rod. Used on mud-slush pumps but finds other uses as rugged construction makes it almost foolproof.

Packing *D* also has flexible lips forced against rod by fluid. On return stroke, friction is reduced slightly. But more gland pressure can be transferred to the packing lips here because of design.



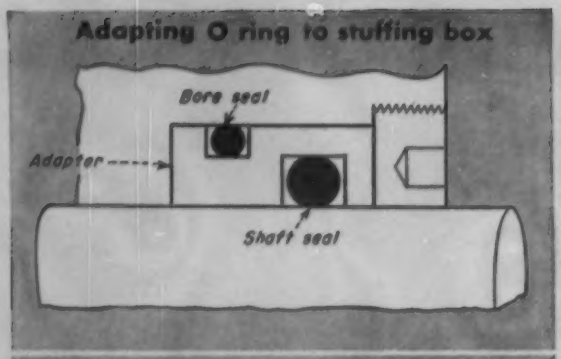


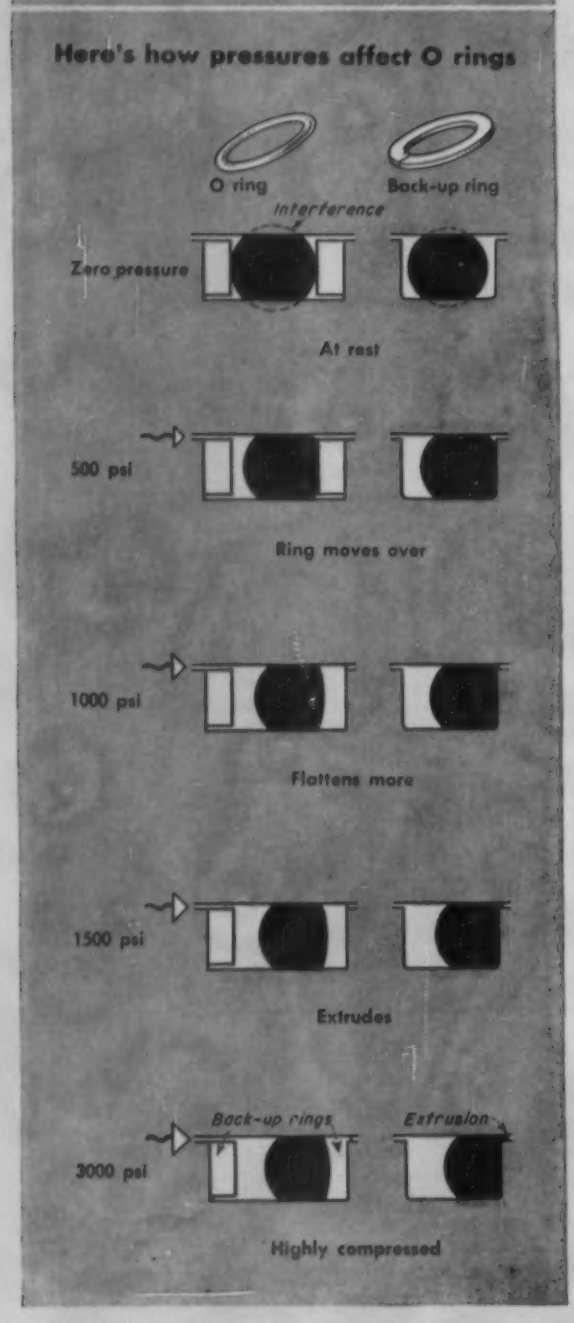
be used and diametral tolerances need not be close—a very important item where machinery must run for long periods.

Under no-load conditions, friction is very low because there is usually enough clearance between heel of ring and cylinder. As pressure increases, heel is brought into contact with cylinder and presses against it. There is always line contact between tip of lip and cylinder, but with increased fluid pressure, more and more of lip comes into contact with wall, until whole packing width is pressed against wall. Pressure at which this happens naturally depends on the hardness of cup material and on its design, which can be controlled.

Friction at heel rises sharply until heel is in contact with cylinder, then friction curve flattens and becomes straight, as with other packings. As with all packing, friction of a U ring varies directly with width in contact with cylinder. While no-load friction is very small, friction at high pressure is much the same as for a rectangular packing of equal width and material.

For high pressures, you can stiffen ring and shorten lip. To make U ring strong as rectangular one, total width, including lip, must be made greater. U rings have many excellent features, might be more widely used than they are today.





O ring seals both ways

Although invented 100 years ago, O rings are just coming into wide use. They are compact, take very little space and are double-acting—sealing equally well in either direction. Space-saving feature is important to today's compact units.

Interference is built into ring, causing it to be squeezed against sliding and static surface without needing gland pressure. Failure from faulty installation is rare because ring can be installed only one way. Interference may be greater than for similar rectangular packing, without increasing initial pressure. Ring and groove dimensions are based on accepted standards. Extrusion is delayed because material is already stressed when it's placed in gap between piston and cylinder. Sketches show how O rings distort.

Extrusion is one drawback of these rings. It's well-known that extrusion of rubber is caused by pressure deforming rubber to extent that it flows into clearances in direction away from pressure. Degree of extrusion depends on pressure, clearance between supporting metal parts, and on hardness of rubber. Back-up rings, of various designs to prevent extrusion, are made of thermo-setting plastics, Teflon, etc.

Experience shows that about 1500 psi is maximum safe pressure with usual clearances. But high pressures can be used with: (1) harder O-ring compound (2) reduced working clearances (3) back-up or nonextrusion devices. Compounding against high temperatures is problem because rubber can't be made resilient enough.

With surface finish, pressure and clearance being equal, O rings have shorter life than V rings, for example. This is mostly because O rings keep sealing only as long as they maintain positive interference against surfaces. When interference, usually 10% of cross-section diameter, is lost from compression set or wear, or both, seal begins to leak.

V ring, on the other hand, not only is molded with greater initial interference, but, because of flexible lip in contact with sealed surfaces, it's also more easily forced against surfaces to be sealed by fluid pressure. But since V ring seals only in one direction, its wear rate may be high during half a complete cycle.

You must weigh somewhat limited life of O rings against advantages. For machines with lower rod speeds, for example, they are ideal. They do a good job if there's film lubrication; their round shape doesn't wipe, destroy film.

Twisting is a problem when rubber is soft or friction is high. Since coefficient of friction is higher for rubber against dry metal than for rubber against lubricated surface, it follows that static or starting friction is higher than dynamic or sliding friction.

Under static conditions, internal pressure of O ring tends to squeeze lubricant film out, leaving rubber-to-metal contact. When motion starts, O ring rolls slightly allowing film of fluid to form between ring and metal. Then rolling changes to sliding motion. But starting friction would be much greater without this rolling action.

Installation failures usually come from sharp corners, threads or cross-drilled ports that don't have necessary bevels or radii to keep from cutting rings. Incorrect clearances and wrong materials are other causes. Spiral failure results from repeated twisting and untwisting, produces rapid straining of rubber under cycling stress.

Compounding is important item with O rings. All rubbers can be compounded for: (1) abrasion resistance (2) low compression set (3) resilience (4) high tensile strength (5) freedom from swelling and shrinking (6) crush resistance (7) thermal stability (8) low-temperature flexibility (9) high-temperature flexibility. Check with ring maker.

T shape doesn't twist

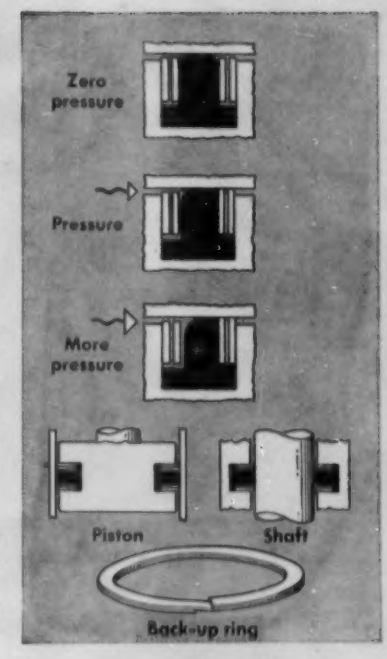
Now comes T-shaped ring with two back-up rings on either side. At zero pressure, sketch, there's clearance between flanges of resilient T ring and back-up rings. This clearance keeps friction at minimum at low pressure.

As pressure is applied, T-ring deforms, swells radially under back-up rings at after end. That forces rings against cylinder, closing piston clearance space, last sketch. Under full pressure, back-up rings are held firmly against cylinder. Now resilient T ring is held tightly against back-up rings, which prevent softer material from extruding into clearance. So back-up rings in this design come into action automatically and gradually, as they are needed to seal increasing pressure.

Makers recommend this ring assembly for pressures up to 20,000 psi. They claim resilient ring won't extrude, wedge or pinch off—also, it won't twist or wind in use. At very high pressures, finer clearances are needed. With extra-heavy back-up rings, packing will work with clearance as high as 0.050 in. Used both as rod seal and piston seal, either for hydraulic or pneumatic service. Rubbers are compounded for –70-F to 250-F service. Two split rings on either side are of laminated phenolic materials. Be sure to stagger joints of back-up rings.

Groove finish also need not be so fine because of little movement between groove and T ring. Maker suggests 75 to 150 microinches (root, mean, square) finish for groove. Rod and cylinder finishes can be standard of 5 to 15 microinches.

One ring assembly on piston or rod is usually enough. In rare cases where two or more must be used, vent space between rings. If not, pressure is trapped, equalizes on both sides of ring and keeps back-up ring from lifting.

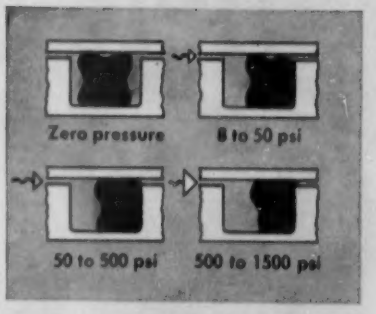


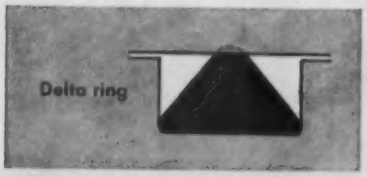
Packings of the squeeze type take little space

Square shape has its place

O rings come in several forms besides usual round cross section. Sketches show this ring with four sealing surfaces instead of two for O ring. Square shape solves spiral twisting problem for hydraulic and pneumatic applications. This ring is designed to fill the packing groove more than other squeeze types.

Square-shape rings can be used in grooves made for regular O rings. They have less movement as pressure changes from side to side on reciprocating applications. Here a 15-microinch surface (profilometer reading) is best. Manufacturer recommends using especially where (1) rings tend to spiral-twist (2) sealing at low pressures is hard (3) lubrication, friction are problems.





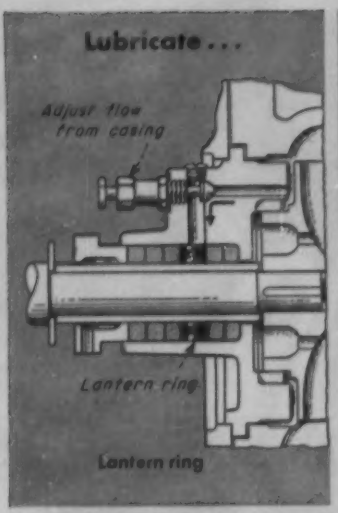
Delta-ring is newest

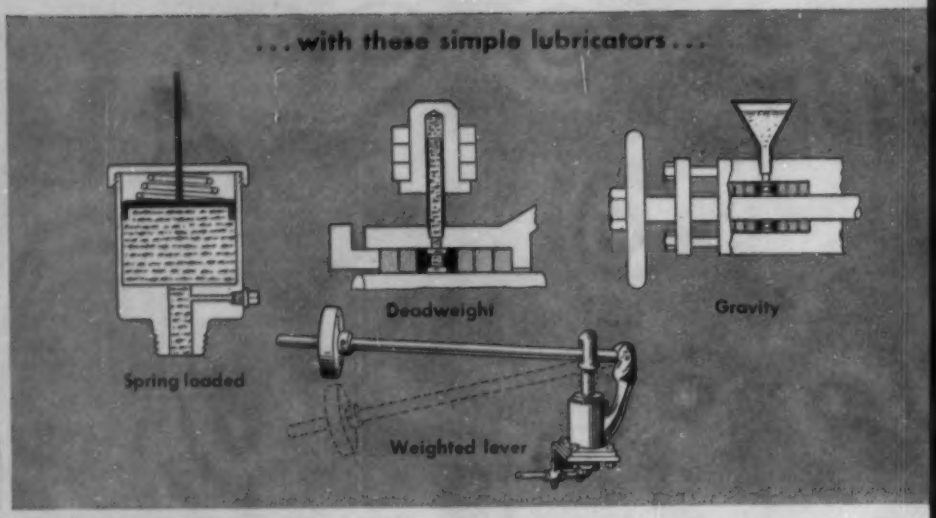
Triangle-shaped ring also solves twisting problem. Life of this ring is shorter because friction is greater—but it does have less tendency to roll than standard O ring. When it fails, though—it fails in a hurry, has limited applications.

Hydraulic-oil specifications

When oil suppliers change additives in oils without indicating what chemicals they use, there may be a packing problem. User adds new oil to system, and rubber in packings fails because it isn't compounded for the new formula. Hydraulic oil must not cause (1) more than 15% swell by volume on commonly used neoprene and buna-N compounds, (2) any serious deterioration in operating temperature range of –25 to 180 F.

Problems from wrong oils: (1) Swell causes binding action, then wear. Machine may even stop. Swell softens rubber, then it deteriorates, extrudes. (2) Delamination occurs when oil attacks rubber between layers. (3) Shrinkage pulls packing away from shaft or cylinder, causes leakage. It is caused by plasticizer leaking out of rubber, especially buna types.





Lantern rings and lubricating systems

For some types of jobs,

We've learned that most types of packings must leak slightly to lubricate the shaft. But sometimes you can't count on such leakage. And if fluid sealed is abrasive or corrosive, you want to keep it out of the packing. One answer is to use a *lantern ring*.

Typical lantern ring, first sketch, is a channeled ring, with radial holes, fitting loosely into the stuffing box. Connection from the casing feeds fluid under pressure to outer channel, radial holes carry it to inner channel. It then flows along the shaft in both directions, insuring lubrication.

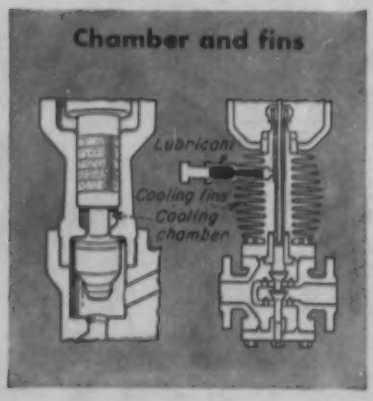
When you need to keep abrasive or corrosive fluids out of the packing, you can't feed the lantern ring from the casing, must turn to an outside source. Water, grease, oil, other fluids, used for this purpose, are usually called "sealing liquid." Under pressure, the sealing liquid bucks fluid trying to leak out of the casing. That reverses flow through packing on the casing side of the lantern ring.

Ring position is important: With lantern ring nearer casing, flow into casing is increased as sealing liquid meets less resistance, flow to atmosphere is decreased. For maximum flushing effect into casing, put lantern ring at bottom of packing set, with no packing between it and casing. This "flushing connection" is used on equipment handling highly abrasive fluids. If you change ring position, be sure ring lines up with sealing connection.

Feeding schemes for sealing liquid are numerous (sketches). For some services, a spring-loaded grease cup is a simple solution. Dead-weight and weighted-lever lubricators are easy to maintain and work without trouble. Just set weight for pressure needed and keep lubricator filled. Large valves are often sealed against vacuum with a funnel filled with water. This also keeps packing from drying out.

Sealing fluid can be injected continuously or periodically, as by a pulsating lubricator or grease gun. Trouble with periodical injection is that fluid from casing gets into stuffing box as soon as injection pressure drops. Continuous sealing flow, at pressure only slightly higher than casing fluid, is best, prevents contaminating casing fluid with sealing liquid.

Oil-bottle hookup, sketch, uses casing



Cooling the packing set

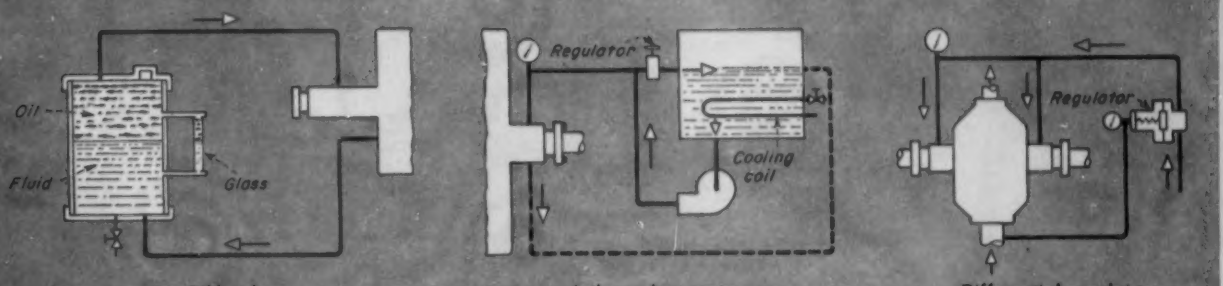
Heat developed in a packing is proportional to product of friction and surface speed. Packing temperature rises until rate of heat dissipation equals rate of heat generation. You can hold down heat by dissipating it with a water-cooled shaft, or by water-jacketing the stuffing box.

Valves often have a so-called cooling chamber between packing and valve body. But there is little temperature drop at packing because most of heat flows through metal, first sketch.

Regulator valve, second sketch, is for extremely high pressures and temperatures. Here cooling fins around stuffing box of long valve stem dissipate heat. Because valve stem moves constantly, must not stick, cartridge of molybdenum-disulfide lubricant is fitted into stuffing box. It won't carbonize or oxidize, helps keep stem free.

High packing temperature leads to excessive thermal expansion that increases load, causing seizure. Cooling and dry lubricant may be only answer.

. . . or with lubrication systems to save packing and shaft



Oil bottle | Independent system | Differential regulator

packing needs to be lubricated from outside

pressure to inject sealing oil, needs no regulator or pump. Just watch gage glass, keep bottle filled with oil. This system uses little oil. When pump is shut down, drain water from bottle, fill with oil, and it's ready.

Circulating system has relief regulator set a few psi above casing pressure. To carry away heat, line from stuffing-box bottom is piped back to tank (dashed line). Fluid in tank can be cooled, if necessary. Differential regulator system keeps a set pressure between casing, gland.

Corrosion. Before injecting sealing liquid, you should know that fluids trapped in stuffing box often cause corrosion. This is known as crevice corrosion, often takes place with fluids that don't corrode metals in an open vessel, but cause damage when trapped in clearance between packing and metal. Packing materials suspected of causing this action are copper and brass reinforcements, also graphite. Oily packings are less likely to give trouble.

One solution for packing that's used with water or aqueous solutions is to install it just before machine is used. Then remove it if unit is to be idle for long periods.

Applications that normally need a sealing liquid include:

1. All packing against gases—they leak excessively because of low viscosity. Also vacuum units, steam engines and turbines, h-p autoclaves where agitator enters gas space at top.

2. All packings for liquids of low viscosity or high volatility (such as gasoline) used at high speeds and high pressures. Examples: Lube oil injected into stuffing boxes of pumps handling propane; oil between double axial seals on water pumps, etc.

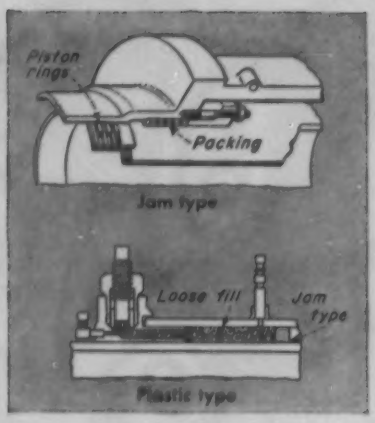
3. Packings for liquids carrying large amounts of dissolved or suspended matter that tends to drop out in passage through packing. Examples: Water-sealed boxes on centrifugal pumps handling caustic soda and on hydraulic turbines operating on muddy or contaminated water.

4. All packings for fluids of any kind that are poisonous, corrosive or too valuable to lose. Examples: Pure gasoline injected into boxes of pumps handling anhydrous hydrogen fluoride in the alkalization process; oil injected into ammonia-compressor rod packing, etc.

Should you swab rods, and oil new packings?

Metallic packing on reciprocating rod may need oil feed, needs no swabbing. Excess oil from swabbing many kinds of steam packings may do harm—isn't needed. You can swab V-type lip packings, but usually even this isn't necessary. Lubricant put into most asbestos packings is all that is needed on steam jobs. Here condensate has lubricating qualities. Laminated-type duck-rubber packings around rams of large hydraulic bloomer-mill shears in steel mills are lubricated by spraying ram with viscous, high-temperature oil every hour or so. But here radiant heat from hot steel is problem.

As for oiling new packing, there is up to 30% saturant in most jam-type packings—so why oil them? Main thing is to see that shafts are not rusty, not covered with abrasive grit and generally in good condition before applying new packing. Like any bearing, shaft should be oily and not dry. If in doubt, wiping the shaft with oily cloth may be good insurance when repacking a stuffing box.

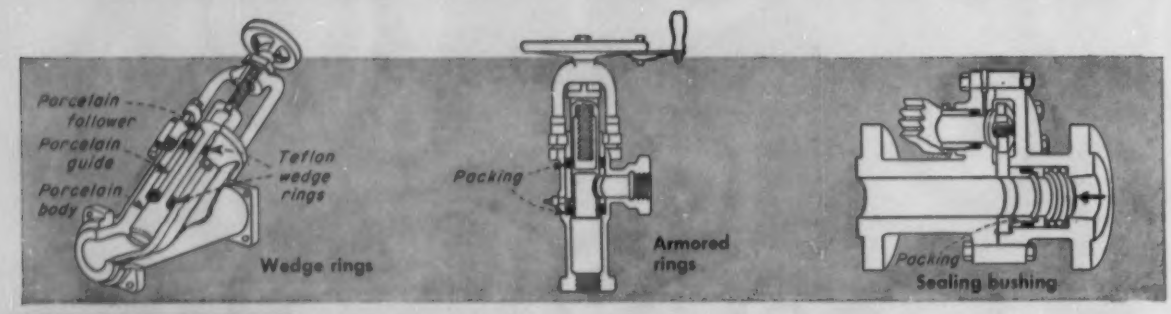


Expansion joints

Metal piston rings, jam-type packing of loose fill, Teflon, etc, are often used singly or in combination to solve problems. Because expansion joints can shut down critical plant areas, some are made to be repacked under full pressure. Top joint shown has three metal piston rings against pressure, then a vent chamber; next, one metal back-up ring and five asbestos-fiber rings on gland end. To repack under pressure, drain chamber of pressure leaking past piston rings. Then back off the gland and add turns of packing needed to fill it.

Second type is packed with loose fill of asbestos, combined with a mineral-oil-impregnated filler. Packing comes in small slugs or in bulk for packing gun. If in slug form, one of several plungers is removed, packing inserted, and plunger screwed down. Asbestos-fiber ring acts as anti-extrusion ring in bottom of packing space. Packing is forced through small channels in gland ring against deflector vanes, which distribute packing in box. Vanes also prevent packing from blowing back. Packing is supplied by joint manufacturer.

You should know how various packing types

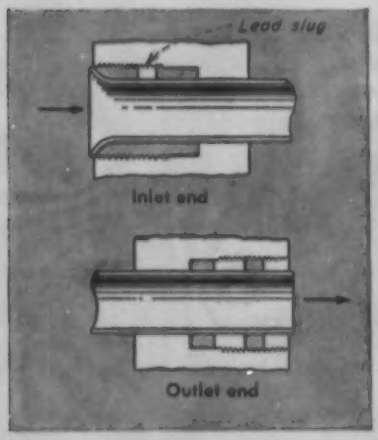


Special valves

Solid Teflon wedge rings seal a porcelain plug valve for highly corrosive chemicals, first sketch. Two sets of wedge rings are separated in long stuffing box by porcelain guide.

Seatless blowdown valve, center sketch, is sealed against high pressure and temperature with two packing rings at each end of ported plunger. Rings are of asbestos and graphite, with part-neoprene binder. Packing ring's stainless-steel reinforcing inserts prevent wearing surface of plunger from harming this fiber packing. Grease fitting lubricates plunger.

Quick-opening valve has spring-loaded sealing bushings, squeezing packing of asbestos composition at constant pressure. No gland adjustment needed for hard-to-get-at packing.



Condenser tubes

Condenser tubes are often rolled and belled on the inlet end, and, therefore, need no packing. If inlet end has been packed, they can be belled over packing rings as in sketch. Outlet end of tube going through tube sheet can act same as an expansion joint, to allow long tube to move as temperatures change.

Outlet ends often have alternate rings of fiber and metal. These metallic endless rings are of thin-gage lead foil, crimped and partly compressed. Metal rings are calked into opening around tubes, causing soft metal to flow and seal along tube and root of threads in tube sheet.

Fiber rings expand rapidly when wet and serve as an excellent seal, while metal ring is more of a spacer in this packing set. An insert plug of lead in fiber ring makes metallic bond between tube and tube sheet.

For high temperatures, rings are made of copper and asbestos foil, compressed and graphited. Or all-copper or all-aluminum foil is used. Here gland is needed as rings calked into opening around tubes won't stay tight.

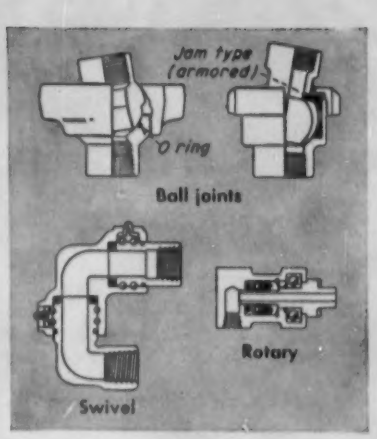
Joints—ball and swivel

Spherical packings for ball joints are widely used. Such joints are in pipes to permit swinging and rotation. Their packings, which must often support ball thrust, are made of firm material like folded asbestos, rubber, etc.

Ball joints of 6000 psi at 350 F are sealed with an O ring squeezed into a groove, first sketch, for 15-deg misalignment. Second sketch is rotary joint of 360 deg and flexing up to 40 deg at same time. Packing is one inner and one outer ring, clamped around ball. Armor at ends prevents extrusion.

Ball-bearing swivel joints come in for heavy service in many industries. They must work freely and not leak. Here, packing ring with armor protects corner of packing at joint. Small grease-retainer packing ring is on atmosphere side of bearing to keep grease from leaking out, see "Swivel" sketch.

High-speed rotating pipe connections, in "Rotary" sketch, are sealed with spring-loaded V rings. For speeds up to 2500 rpm, pressures up to 300 psi (air), or 1500 psi (hydraulic) temperatures up to 180 F, depending on packing used.

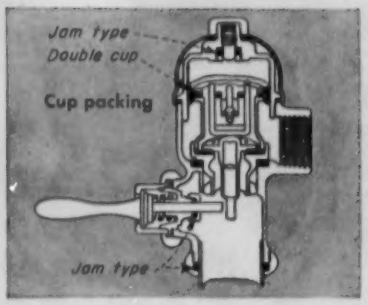


are adapted to particular application needs

Flush valves

Flush valves are used in great numbers in all large buildings, factories. Keeping them at work falls to the power-services department and packing used has a lot to do with valve's success. Here handle plunger, regulating screw and expansion joint have packing.

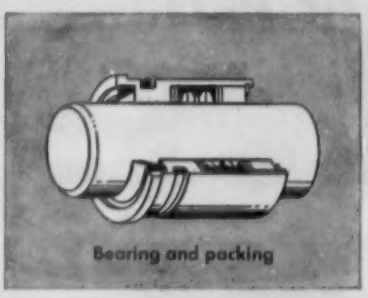
Piston packing gets toughest service. Sketch shows molded-rubber double cup, reinforced with metal insert. Cups for these valves may be one of the rubbers or leather. Valve generally operates on water at about city-water pressure, so service isn't tough. But packing must be right or maintenance can be costly. These valves have many static seals also. Once a packing is disturbed, during repairs, it's best to renew it.



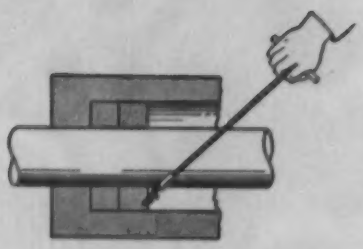
Packed cartridge is new

Packed cartridge fits over shaft end into stuffing box, is both a fixed bearing and seal. Bronze bearing holds piston and rod concentric within cylinder. Stiff segmented metallic sealing rings nest into pliable cushion rings. Fluid tends to distort cushion rings, automatically tightening metallic rings around shaft. As pressure drops, reaction is reduced, thus lowering friction. Two bronze, slotted rod wipers with knife edges are springy, keep pressure against rod.

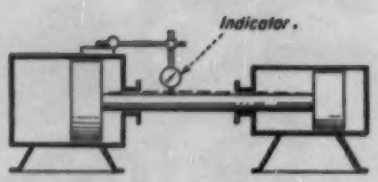
For reciprocating motion to seal oil, water, steam, air, gas, ammonia; up to 300 F. Cartridge is sealed on outside by O rings, needs no gland adjustment.



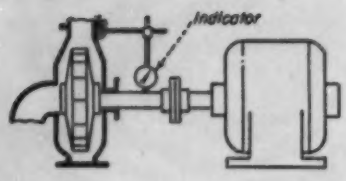
EDITOR'S NOTE Floating packings and oil seals belong in this report, but we just couldn't get them in—no space. But don't worry, we'll get them in our final report on MECHANICAL SEALS, scheduled for March 1956. For more information on plunger and piston packings, send for 24-p report on PISTON RINGS. For detailed information on chemical composition, temperature and pressure limitations, of various packing materials, send for 20-p report on GASKETS, where we covered these characteristics fully.



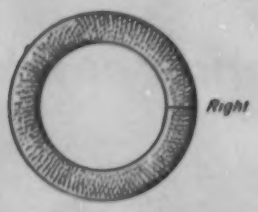
1 Remove *all* old packing. Aim packing hook at bore of the box to keep from scratching the shaft. Clean box thoroughly so the new packing won't hang up



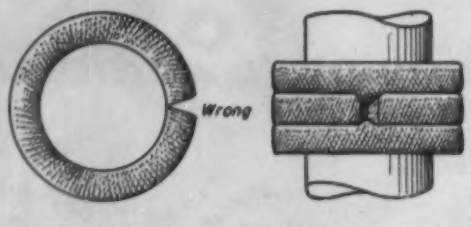
2 Check for bent rod, grooves or shoulders. If the neck bushing clearance in bottom of box is great, use stiffer bottom ring or replace the neck bushing



3 Revolve rotary shaft. If the indicator runs out over 0.003-in., straighten shaft, or check bearings, or balance rotor. Gyrating shaft beats out packing

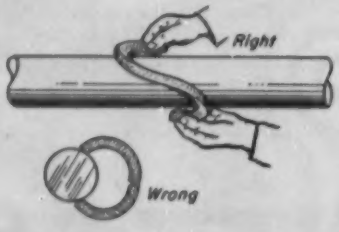


6 Cutting off rings while packing is wrapped around shaft will give you rings with parallel ends. This is very important if packing is to do job

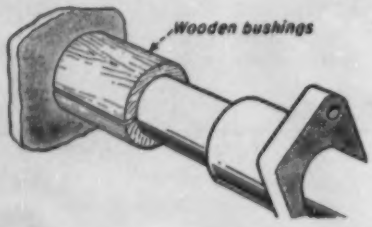


7 If you cut packing while stretched out straight, the ends will be at an angle. With gap at angle, packing on either side squeezes into top of gap and ring, cannot close. This brings up the question about gap for expansion. Most packings need none. Channel-type packing with lead core may need slight gap for expansion

Third: ***Now let's learn how to install packing correctly and cut down costly outage***

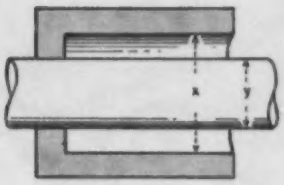


11 Open ring joint sidewise, especially lead-filled and metallic types. This prevents distorting molded circumference—breaking the ring opposite gap

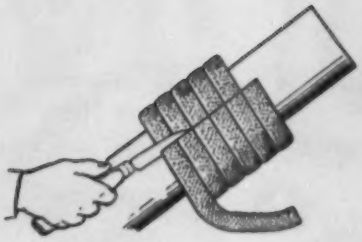


12 Use split wooden bushing. Install first turn of packing, then force into bottom of box by tightening gland against bushing. Seat each turn this way

15 Always install cross-expansion packing so plies slope toward the fluid pressure from housing. Place sectional rings so slope between inside and outside ring is toward the pressure. Diagonal rings must also have slope toward the fluid pressure. Watch these details for best results when installing new packing in a box

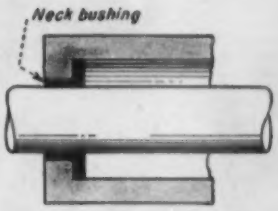


4 To find the right size of packing to install, measure stuffing-box bore and subtract rod diameter, divide by 2. Packing is too critical for guesswork.



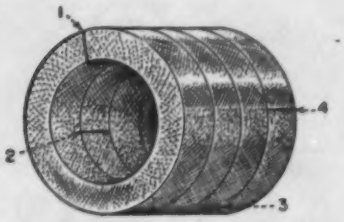
5 Wind packing, needed for filling stuffing box, snugly around rod (for same size shaft held in vise) and cut through each turn while coiled, as shown. If the packing is slightly too large, never flatten with a hammer. Place each turn on a clean newspaper and then roll out with pipe as you would with a rolling pin

8 Install foil-wrapped packing so edges on inside will face direction of shaft rotation. This is a must; otherwise, thin edges flake off, reduce packing life

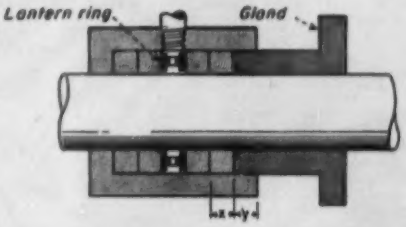


9 Neck bushing slides into stuffing box. Quick way to make it is to pour soft bearing metal into tin can, turn and bore for sliding fit into place

10 Swabbing new metallic packings with lubricant supplied by packing maker is OK. These include foil types, lead-core, etc. If the rod is oily, don't swab it



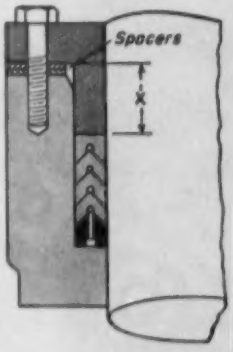
13 Stagger joints 180 degrees if only two rings are in stuffing box. Space at 120 degrees for three rings, or 90 degrees if four rings or more are in set



14 Install packing so lantern ring lines up with cooling-liquid opening. Also, remember that this ring moves back into box as packing is compressed. Leave space for gland to enter as shown. Tighten gland with wrench—back off finger-tight. Allow the packing to leak until it seats itself, then allow a slight operating leakage.

Hydraulic-packing pointers

First, clean stuffing box, examine ram or rod. Next, measure stuffing-box depth and packing set—find difference. Place ⅛-in. washers over gland studs as shown. Lubricate ram and packing set (if for water). If you can use them, endless rings give about 17% more wear than cut rings. Place male adapter in bottom, then carefully slide each packing turn home—don't harm lips. Stagger joints for cut rings. Measure from top of packing to top of washers, then compare with gland. Never tighten down new packing set until all air has chance to work out. As packing wears, remove one set of washers, after more wear, remove other washer.



Here's how gases and fluids you seal

Medium to seal	Metals	Natural rubber or GR-S	Neoprene	Buna N	Thiokol
GASES					
Air or oxygen up to 700 F	Little effect (except lead melts above 600 F)	Hardens or becomes tacky. May ignite in oxygen	Hardens and decomposes at temperatures above 300 F	Hardens	Volatile at temperatures above 212 F
Halogens (chlorine, bromine, etc)	No effect if free from water. Otherwise attacked	Hardens on exposed surfaces	Hardens on exposed surfaces	Hardens on exposed surfaces	Hardens on exposed surfaces
Other hot gases or dry steam	Little or no effect below melting point of metal. Hot compressed hydrogen embrittles steel	Hardens or becomes tacky	Hardens. Decomposes at temperatures above 300 F	Hardens	Volatile at temperatures above 212 F
LIQUIDS					
Water (including all neutral water-soluble salts, sugar solutions, etc)	No effect, except iron rusts	No effect except slow swelling	Swells—especially in fabric constructions	No effect except slow swelling	No effect at temperatures below 212 F except slow swelling
Alkaline solutions	Dissolves lead, tin, zinc, aluminum and alloys. No effect on iron, copper or nickel	Slow swelling. Reversion at very high temperatures	Swells—especially in fabric constructions	No effect except slow swelling	No effect at temperatures below 212 F except slow swelling
Weak acid solutions (including acetic and other organic acids, sulfurous acid and low concentrations of sulfuric and hydrochloric)	Little effect on copper and copper alloys. Attack iron (unless chromium alloy). Acetic acid attacks lead. Aluminum resists organic acids only	No effect except slow swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers
Strong acids Hydrochloric acid	Attacks all metals except Hastelloy, gold and platinum	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers
Sulfuric acid	Attacks all metals except Duriron, lead, gold and platinum	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers
Concentrated sulfuric acid	No effect unless dilution occurs	Carbonized	Carbonized	Carbonized	Carbonized
Concentrated acetic acid (glacial)	No effect unless dilution occurs	Slight swelling only, if compound is free from acid-soluble fillers	Slight swelling only, if compound is free from acid-soluble fillers	Slight swelling only, if compound is free from acid-soluble fillers	Slight swelling, only if compound is free from acid-soluble fillers
Nitric acid	Dissolves all metals except Duriron, gold and platinum. (Stainless steel resists concentrated but not dilute)	Destroyed	Destroyed	Destroyed	Destroyed
Aqua ammonia	Attacks all copper alloys. No effect on other metals	No effect	No effect	No effect	No effect
Liquid ammonia (anhydrous)	Attacks all copper alloys. No effect on other metals	No effect except from heat and oil associated with ammonia	No effect	No effect	Little if any effect
Liquid chlorine, bromine, etc	No effect if free from water. Otherwise attacks all metals	Destroyed	Destroyed	Destroyed	Destroyed
SOLVENTS					
Aliphatic (gasoline, etc)	No effect	Swells excessively	Swells slightly	Swells very slightly	No effect
Aromatic types (benzol, etc) or chlorinated types (carbon tetrachloride, etc)	No effect	Swells excessively	Heavy swelling	High swelling	Moderate swelling
Acetone	No effect	No effect except extracts softeners	High swelling	High swelling	Moderate swelling
Alcohol	No effect	No effect except extracts softeners	No effect except extracts softeners	No effect	No effect
OILS	No effect except high-sulfur hot oils attack copper, iron and alloys	Swells strongly with cold oils. Reverts and dissolves with hot oils	Swells moderately at temperatures up to 300 F. Decomposes at higher temperatures	Slight shrinkage or swelling depending on aromaticity of the oil	No effect at temperatures below 212 F

Information given here is very general, cannot give you complete answers. While you must know chemical effect on packing material, remember that usually packing isn't fully exposed to gas or liquid being sealed. Experience shows that mechanical properties of packing usually are more important than chemical ones. That simply means reaction to materials

get along with your packing materials

Silicone	Phenolic resins	Teflon	Asbestos	Blue asbestos	Cotton, flax, viscose rayon	Leather
No effect except slow hardening. Decomposes at temperatures above 500 F	Little effect	No effect up to 500 F	No effect	No effect	Weakens and may ignite above 300 F	Hardens. May ignite in oxygen
Hardens on exposed surfaces	No visible effect	No effect	No effect	No effect	Weakens	Hardens
Softens. Decomposes in steam	No effect	No effect up to 500 F	No effect	No effect	Weakens at temperatures above 212 F	Hardens at temperatures above 212 F
Swells and eventually decomposes—rate depending on temperature	Very slight swelling	No effect	Tendency to disintegrate in absence of waterproof binder	Tendency to disintegrate in absence of waterproof binder	No effect unless superheated	Loses waxes. Shrinks and hardens on drying
Swells. Decomposes when solutions are strong and hot	Very slight swelling unless solutions are strong and hot	No effect	Hardened by strong alkalies	No effect	Destroyed by strong, hot alkalies	Destroyed
Swells and eventually decomposes	No effect except slight swelling	No effect	Very little effect	No effect	Weakens	Loses waxes. Shrinks and hardens on drying
Swells. Rapid decomposition	No effect except swelling	No effect	Hardens and partly dissolves	No effect	Destroyed	Fairly resistant
Swells. Rapid decomposition	No effect except swelling	No effect	Hardens and partly dissolves	No effect	Destroyed	Fairly resistant
Carbonized	Carbonized	No effect	No effect unless dilution occurs	No effect	Destroyed	Destroyed
Slight swelling	Very slight swelling	No effect	No effect	No effect	No effect	No effect
Destroyed	Destroyed	No effect	Hardens and partly dissolves	No effect	Destroyed	Destroyed
Swells and eventually decomposes	No effect	No effect	No effect	No effect	No effect	No effect
Little effect	No effect	No effect	No effect	No effect	No effect unless heat is present	No definite data
Destroyed	Destroyed	No effect	No effect	No effect	Destroyed	Destroyed
Slight swelling	No effect	No effect	No effect	No effect	No effect	Loses waxes, shrinks and hardens
Swells excessively	Very slight swelling	No effect	No effect	No effect	No effect	Loses waxes, shrinks and hardens
Little effect	Slight swelling	No effect	No effect	No effect	No effect	Loses waxes, shrinks and hardens
Little effect	Slight swelling	No effect	No effect	No effect	No effect	Loses waxes, shrinks and hardens
Moderate swelling	No effect	No effect	No effect	No effect	Weakens at temperatures above 212 F	Loses waxes and tends to become porous. Hardens at temperatures above 212 F

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you select may not be in same degree as indicated on chart. This chart will help steer you in general direction when selecting packings, but don't forget it's not the full answer. Packing design, condition of shaft, how packing is installed, shaft speed, etc, are all important. So *please* don't accept or reject packing on these data alone. They're only a guide.

And here's the right packing for each job

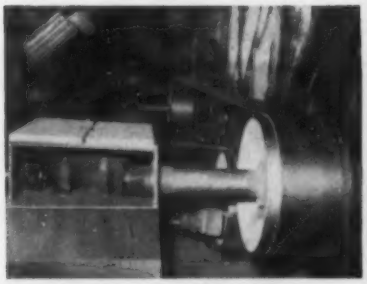
Medium	Centrifugal and rotary shafts	Reciprocating rods, plungers and rams	Piston or cylinder packing	Valve stems
Steam High pressure	Asbestos Metallic Semi-metallic Plastic (loose fill)	Lip types Asbestos Metallic Semi-metallic Plastic (loose fill)	Metallic	Asbestos Metallic Semi-metallic Plastic (loose fill)
Steam Low pressure	Asbestos Metallic Semi-metallic Plastic (loose fill)	Lip types Asbestos Duck and rubber Metallic Semi-metallic Plastic (loose fill)	Metallic Duck and rubber Amberite Lip types (piston)	Asbestos Duck and rubber Semi-metallic Plastic (loose fill)
Water Hot	Asbestos Semi-metallic Plastic (loose fill) Mechanical seals	Lip types Duck and rubber Semi-metallic Plastic (loose fill) Leather Squeeze types	Duck and rubber Molded cups Hard rubber Amberite Lip types (piston) Cup (piston) Squeeze types	Asbestos Duck and rubber Semi-metallic Plastic (loose fill) Squeeze types
Water Cold	Asbestos Flax, jute or ramie Cotton or rayon Semi-metallic Plastic (loose fill) Mechanical seals	Lip types Flax, jute or ramie Duck and rubber Leather Plastic (loose fill) Semi-metallic Squeeze types	Duck and rubber Molded cups Lip types (piston) Cup (piston) Squeeze types	Asbestos Duck and rubber Flax or cotton Semi-metallic Plastic (loose fill) Squeeze types
Gasoline and oils Hot	Asbestos Semi-metallic Plastic (loose fill) Mechanical seals	Lip types Asbestos Semi-metallic Plastic (loose fill)	Hard rubber Amberite Lip types (piston)	Asbestos Semi-metallic Plastic (loose fill)
Gasoline and oils Cold	Asbestos Semi-metallic Plastic (loose fill) Mechanical seals	Lip types Asbestos Semi-metallic Plastic (loose fill) Squeeze types	Hard rubber Amberite Leather Lip types (piston) Cup (piston) Squeeze types	Asbestos Semi-metallic Plastic (loose fill) Squeeze types
Air	Asbestos Semi-metallic Plastic (loose fill) Mechanical seals	Lip types Asbestos Metallic Semi-metallic Plastic (loose fill) Squeeze types	Metallic Molded cups Leather Lip types (piston) Cup (piston) Squeeze types	Asbestos Semi-metallic Plastic (loose fill)
Gas	Asbestos Semi-metallic Mechanical seals	Lip types Asbestos Metallic Semi-metallic Squeeze types	Metallic Molded cups Leather Lip types (piston) Cup (piston) Squeeze types	Asbestos Semi-metallic
Acids and caustics	Asbestos (blue) Semi-metallic Plastic (loose fill) Mechanical seals Teflon	Asbestos (blue) Metallic Semi-metallic Plastic (loose fill) Teflon	Hard rubber Lip types (piston) Teflon	Asbestos (blue) Semi-metallic Plastic (loose fill) Teflon
Ammonia	Asbestos Semi-metallic Mechanical seals	Duck and rubber Metallic Semi-metallic	Duck and rubber Hard rubber	Asbestos Duck and rubber Semi-metallic

Tips on mechanical packing

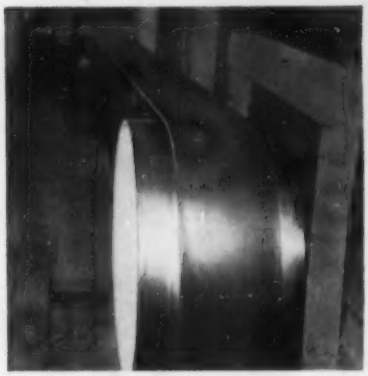
- Packing must be bought by engineer using it, never by purchasing agent who knows nothing of problems.
- Always have a spare set in stock, but don't overstock packing. Don't store in hot, dirty place.
- Never throw away packing set that failed. Save for packing maker to examine — it tells him many things about operating conditions.
- Use boots to protect rams if abrasive dust is problem, or coat with dense chromium.
- If long stuffing box adds to friction, use spacer in the box to reduce the number of rings in set.
- Hydraulic packing on moving piston should be endless rings, if possible.
- Remember, over-tightening is greatest cause of packing failure.
- If rams are grooved or worn, recondition as no packing stands up under these disadvantages. On high-pressure jobs, make clearance as close as possible to avoid extrusion.
- If bushing on large female adapter is worn, renew bushing. If emergency repair, use special female adapter ring.
- Packing is usually weakest link in any machine. Wrong packing—or right packing improperly installed—can be very costly.
- Tell manufacturer about application. For example, forging press is under shock load, so packing must be more robust type. If low-pressure job, lips must be more flexible than for high pressures, etc.
- Always remove all turns of old packing from a box. If female adapter for lip-type packing keeps failing, make adapter of soft metal as it takes all packing load.
- Clean stuffing box thoroughly with abrasive cloth after removing old packing. Also, clean the ram.

Power acknowledges

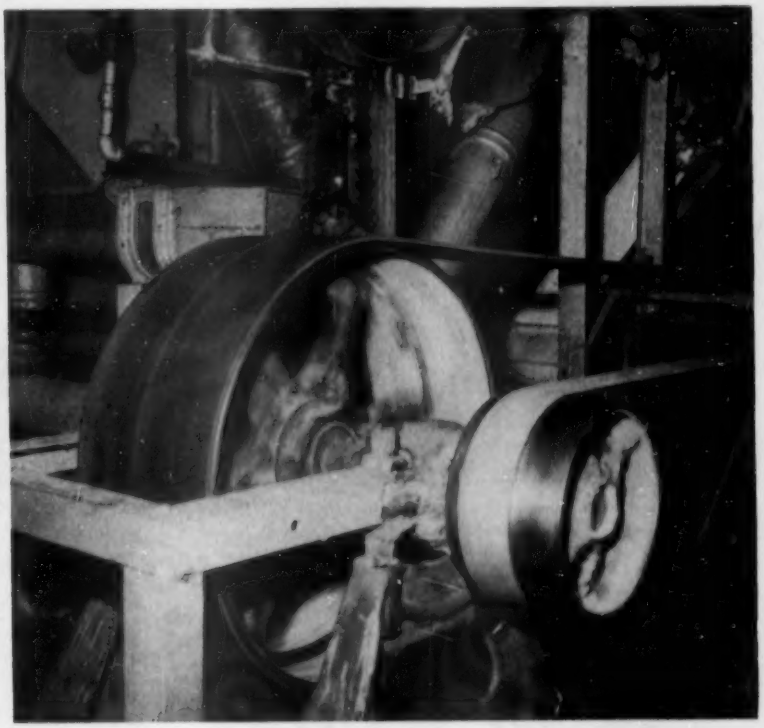
hearty cooperation of packing manufacturers in providing technical data, sketches. We especially thank the following for personal discussions: J W Axelson, E Bastelet Jr, T Bessent, W T Blair Jr, J C Burggraff, L H Carr, A Cichelli, W Ehlers, J W Fisher, L J Fitz Gibbon, D B Grassett, L J Gregoire, G F Helbach, G E Horvath, J Knight, H Lona, W.M Lewis, M Main, H C Mathies, F C Merton, A E Munch, G W Ostendorp, E J Parker, R Pyles, C Schaeffer, P Shank, W P Sinclair, R F Stone, E H Stutenroath, J C Thorn, J Tomon, H Poulner, R Van Ness, O W Wagner, J N Walton, H T Wheeler, R L Whitaker.



Tough hog-drive service



Auxiliary drive



Hot, oily cotton-gin duty

Neoprene belts can take abuse

► WHILE A BELT of any material transmits power, the belt that gives the best performance is the one best suited to operating conditions. Sometimes this must be determined by trial and error.

Any flat belt drive is flexible, can increase or reduce speed, absorb a certain amount of shock. Properly designed, installed and maintained, it gives good service if you choose the right material.

Where shock loads, excessive heating, exposure to sunlight or dripping oil are factors, neoprene belt may be the answer to transmission problems.

This material resists oil. Also, its reaction to heat caused by friction between belt and pulley permits considerable slip if driven machine is temporarily stalled by an overload. When a shock load occurs, belt slips on the drive pulley, generating heat. The pulley surface of a neoprene belt grows hard and glazed as the result of this heat, allowing belt to slip farther without breaking.

Installations pictured above are putting neoprene belting to the test. Right now, the results look good.

Hog drive in a lumber mill is one of the world's worst services for power-transmission belts. Trimmings from all over the mill are dumped into the hog and reduced to bits that can be blown to a boiler and burned. Some of these trimmings and slabs are chunks of considerable size. Jarring stops, shock overloads and sudden reverses are routine to the drive belt.

Sometimes, when the hog stalls completely and the drive pulley continues to run, friction heats the belt to the point where it actually smokes. Like many other industrial transmission belts, a hog belt catches its share of grease and oil from dripping bearings.

The Matthews Lumber Co at Mansfield, La. is using a 12-in. 5-ply neoprene-rayon belt, 60 ft long, on the hog drive pictured. There are no apparent signs of wear after more than a year of service. Other belts on this drive had to be replaced after only 10 to 12 months of operation.

This mill also has a neoprene belt powering individual drives for the resaw, trimmer, roller bed and screw conveyor. The belt is a 12-in. 5-ply neoprene-rayon construction, 50 ft long, transmitting 150 hp at peak loads. It also shows no sign of wear after more than a year of service.

A 12-in. 5-ply cotton-neoprene belt, 50 ft long, on hog drive service at another Southern lumber mill shows little wear after driving the unit for two years.

Cotton gin service makes similar demands on the transmission belt. It also must be able to withstand frictional heat and lubricating oil. The wide belt pictured, in right photo, is on the main drive at East Point Cotton Gin in Louisiana. In its second year of operation, it has not broken once and still looks like new. The belt is 14 in. wide, 7 ply and 47 ft long. It travels 3800 fpm, is driven by a 150-hp motor.

TRANSFORMER OIL leak ruined this rubber cable. Check on most insulations to prevent oil-wicking up a power cable

CHLORINATED HYDROCARBONS disintegrated this concrete-enclosed fiber duct, then ate through rubber, neoprene insulation

Are plant chemicals trimming life from your cables? Here's one answer

Where electrical distribution cables are exposed to harmful chemicals, newer synthetic insulations may be your best bet in preventing cable failures. At least that's the experience of this Texas plant after wrestling with problem for years

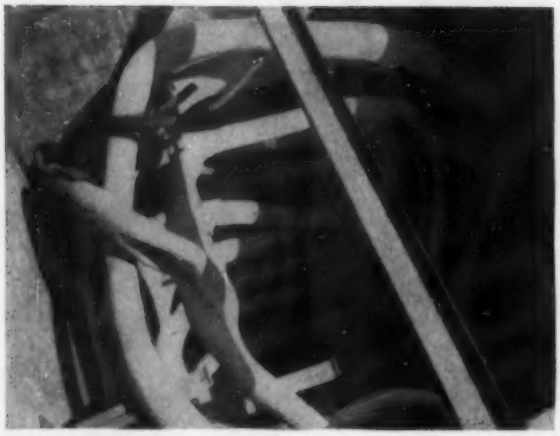
By **J E PARKER**, *Utilities Engineering Supervisor*
Carbide and Carbon Chemicals Company

► WHEN THE ORIGINAL cable installation was made in our plant, all reasonable precautions were taken to insure a sound, trouble-free electrical distribution system. All cables in both the 2400- and 480-volt systems were installed in 4-in. reinforced-concrete-encasing fiber ducts. Duct banks were laid about five to six feet below grade. Then cable pits were set in these duct runs at intervals of about 200 to 600 feet to handle local takeoffs or for splicing and pulling.

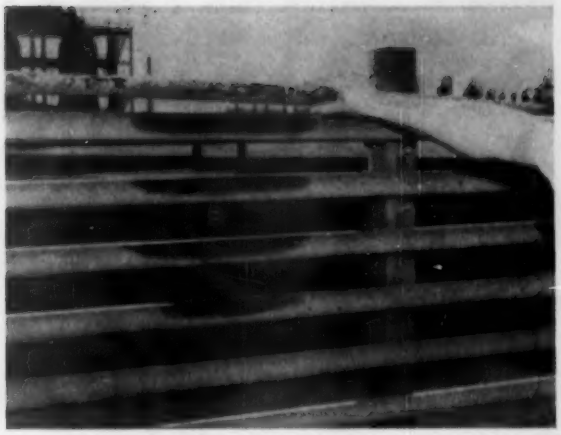
All cables in these pits were racked, fireproofed and tagged. But no provision was made for drainage of the underground system. This oversight proved a serious handicap, leading in time to several cable failures. Any expansion of the original system was provided with necessary drainage by interconnecting logical groups of pits with 4-in. drainage tile beneath duct banks. Every so often sumps were spotted to handle these drains. Each sump had an automatic float-operated sump pump.

Providing for proper drainage has made a significant improvement in operating our underground distribution system.

Overhead distribution was adopted in a few isolated locations where it would have been impractical to install cables



TYPICAL CABLE PIT showing cables racked, fireproofed, tagged. But no drainage plans were made for the original installation



GALVANIZED CONDUIT, *top,* after 4 years in plant. Polyethylene-coated conduits, below galvanized run, not affected

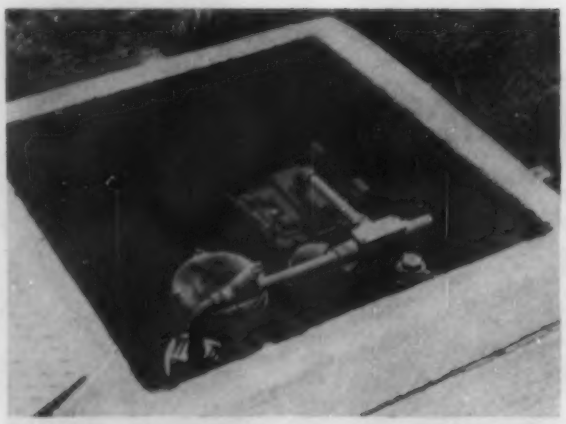
Handy operating facts for underground distribution

- Reinforce all ducts and install far enough below grade to prevent mechanical damage from ground-level loadings. Connect duct banks to cable pits so underground system is essentially waterfree. Also, seal conduit extensions from the underground system where they rise above ground level. This precaution keeps out surface water and possible contaminants.
- Make cable pits watertight and their tops high enough above ground to prevent entry of surface waters. Provide drainage for all cable ducts and pits.
- Space cable pits close enough so cable jacket stress during pull-in is held within cable limits. Avoid routing cables of different voltage classes through the same pit . . . this is primarily a personnel safety feature.
- Rack all cables in pits, leaving some slack in each run. Put a fireproof covering over all cables exposed in pits. Place permanent identification tags on all cables *in each pit.* If possible, avoid leaving the cable insulation in a stressed condition. Make sure any lubricant you use during pull-in will not affect cable jacket.
- When subway-type transformers are used, take care that oil leakage does not contact the cable either through the stranding or by entering the conduit. Take close note of taping procedures to insure waterproof splices. Hydraulically applied connectors are preferred. Bolted connectors might lead to insulation failure because of stress concentration at sharp points. If bolted connectors must be used, wrap semi-conducting tape directly over the connector, then cover with insulating tape.
- Use equal numbers of nonshielded cables for each phase in any duct to avoid inductive heating. Provide for adequate cooling of all conductors.

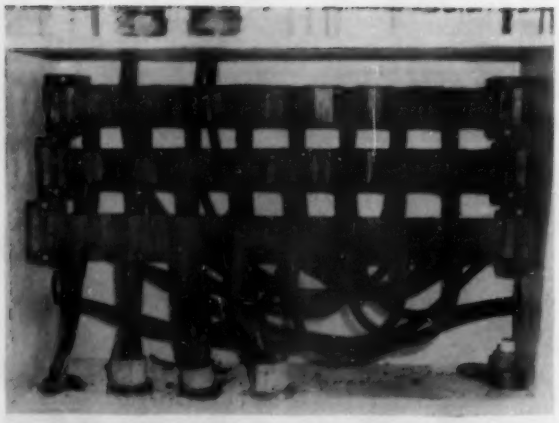
underground. Here cables were installed in 4-in. galvanized conduit. All motor leads were placed in galvanized conduit underground when immediately adjacent to switchgear, overhead when carried to a remote point.

The corrosive atmosphere, both natural and induced, deteriorated the overhead lines in short order, and in several spots. Attempts were made to counteract the problem with special paints, plastic conduit, nonferrous tubings, etc. But we met with little success until we tried polyethylene-coated conduit. Results have been good. We've even made some direct burial installations without the customary concrete enclosure.

Cable materials in the original installation were varnished cambric, lead sheath; rubber and neoprene. These were for sizes No. 2 through 500 Mcm. Later, expansion saw increased use of butyl rubber with neoprene jacket. And in recent years most installations have been made with plastic insulated and jacketed cables, using polyvinyl chloride for 600-v service and polyethylene with a polyvinyl chloride jacket for 5- and 15-kv service. All expansion now calls for nonmetallic sheathed cable. Most of the lead-sheathed cable installed originally have since been replaced with nonmetallic types. Now with the above



SUMP AND PUMP SETUP for cable system. Convenient groups of pits were interconnected with 4-in. drain tile below ducts



TRANSFORMER BANK connecting-block set up after leaking bushing started trouble. Delta formerly made at distant gear

'Drainage scheme helped cut cable failures'

background on types of cables used, let's scrutinize our operating history.

First six months of operation saw three interruptions caused by ground faults on the 2.4-kv lighting circuits. Each fault was at a point where single-phase takeoffs were spliced to the feeders. Repairs were speedily made, however, since these splices were right in cable pits. Each of these faults was directly chargeable to poor workmanship in taping the splices. Other failures followed. Two showed up on a 480-v feeder serving a unit switchrack. This was a 3-conductor *VCL*, and probably failed because of lead-sheath corrosion, traced to high-alkalinity water seeping into the duct run.

But only one major outage involving more than one load center has occurred during 13 years of operation. That trouble occurred in January 1943 and gave its first warning by way of a ground indication. At the time all cable pits were flooded. This fault gave way some hours later to a fire in the cable pit, ruining insulation on all other cables in the pit. Fortunately it was possible to resplice most of the cables by pulling slack from all directions.

What caused the fault? Because of the cable-pit fire it was tough to pin down a precise cause, but insulation on one circuit was burned off about four feet back in the duct. We assumed the first fault and short circuit were at this point. We further assumed an insulation failure occurred traceable either to damage that developed during installation or to a fault in the insulation itself. Had the cables been removed from service long enough to localize the fault, resulting repairs would have been simple and a major power interruption avoided.

Back in 1947 two other failures occurred on the 480-v circuits. Each of the four sets of three cables passed underground about 65 feet in 4-in. galvanized conduits placed side by side. Conduits were overheating because of poor ventilation. To correct the temperature condition, air from the plant was circulated through the ducts. Even though the air was filtered, a small amount of oil was carried into the underground ducts leading in time to an insulation failure. Single sets of cables were replaced on two occasions during 1947. Eventual solution was to install overhead conduit to replace the duct runs.

More recent cable failure on the 2.4-kv lighting loop resulted when chlorinated hydrocarbon was spilled in the vicinity of the cable runs. The chemical ate through concrete and fiber of the duct run and dissolved both rubber and neoprene insulation and jacketing. This led in short order to a 3-phase fault. This duct run was replaced and polyethylene cable installed. There's no indication of trouble after 3½ years of service even though some of the chemical was present in the duct when new cable was installed.

Above listing of failures is no doubt peculiar to the fact that we are in the chemical business. And, paradoxically, it was modern chemistry that supplied our answers to the cable failures. Here follows a positive rundown on some facts we believe could well be adopted by other engineers for tough industrial areas.

For instance, not too long ago we installed an emergency power circuit of three single-conductor cables with a 5-kv polyethylene insulation and polyvinyl-chloride jacket. Half of this cable run is by direct burial in the ground. Only protection given the cable was the use of sand for backfill immediately adjacent to it, plus creosoted planking to avoid mechanical damage. This installation has been satisfactory and proved low cost.

We have come to the conclusion that our needs, cablewise, must be tailored about our fairly high concentration of chlorides, hydrocarbons, acids, alkalies. So any cable insulation we select must stand up under moisture, alkalies, acids, hydrocarbons (especially chlorinated hydrocarbons), elevated temperatures. In addition, any cable must offer top abrasion resistance, some degree of flexibility, minimum over-all diameter for given copper diameter, etc.

What's wrong with many of the presently used cable insulating materials? Perhaps nothing when they're applied within their normal limits. We've used (1) varnished cambric, lead-sheath (2) oil-based rubber with neoprene jacket, (3) butyl-rubber with neoprene jacket, (4) polyethylene with polyvinyl-chloride jacket.

We've found the *VCL* cable costly,

awkward to handle, tough to splice and susceptible to attack by alkalies and acids, especially when chlorides and acetate ions are present. Lead sheaths are also susceptible to electrolytic corrosion, often requiring cathodic protection. On the other hand, the oil-based rubber cables are easy to handle and splice, but are subject to chemical attack.

Perhaps we're supercritical because we are in the chemical business, but service continuity demands that we be. We have found polyethylene insulation with polyvinyl-chloride jacket most satisfactory. It has the smallest over-all diameter for a given copper size, is least expensive, easy to splice, offers good resistance to mechanical and chemical damage. Polyethylene as used for electrical insulation resists practically all solvents. *Caution: Polyethylene has a melting point of 110 C so it's important to have adequate circuit protection to assure quick clearing of short circuits and overloads.*

Splices are a major source of potential trouble in any underground distribution system. We estimate that 90% of circuit failures in an underground system are caused by improperly made splices. The splicing technique differs depending on the type cable used. But always the copper conductors are first connected with sleeves. A *VCL* conventional splice consists of varnished cambric tape and compound covered by a lead sleeve wiped onto the cable's sheath. With rubber-neoprene, the joint is first wrapped with rubber insulating tape, covered with neoprene jacket tape. Then the entire splice is covered with cotton or friction tape. A coat of insulating waterproof compound is then applied.

For polyethylene, a self-vulcanizing polyethylene tape is used, over which a wrapping of polyvinyl tape is placed. Whole splice is then covered with two alternate layers of cotton or friction tape and waterproof sealing compound.

Tinned sleeves, used for many years to connect the copper conductors, have recently been abandoned in favor of straight copper sleeves applied with a hydraulic jack. These newer sleeves are superior in mechanical strength, electrical conductivity, and can be installed more quickly. They also sidestep the need for soldering. Open flames are taboo in a chemical plant.

Over 170,000 feet of 5- and 15-kv polyethylene insulated and polyvinyl-jacketed power cable in 250 and 500 Mcm sizes have been installed in our plant in the past six years, some under tough operating conditions. To date there has not been a single failure.

New tricks in plastic molding

► Stokes Molded Products Div of The Electric Storage Battery Co has announced a new technique for molding refractory plastics like pure polyvinylchloride (pvc). For the first time it is now possible to economically process rigid pvc into intricate and complex moldings, not only for large production runs but also for small lots. Lunkenheimer Co valve above is one example of what this new process does.

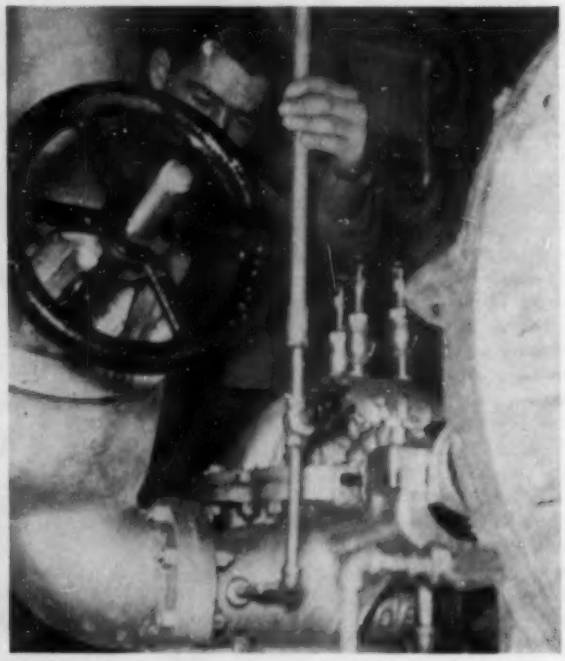
Rigid pvc is well-known for its resistance to corrosive fumes and liquids, as well as industrial chemicals, reagents and wastes. Valves and fittings made of this material are said to be as good as stainless steel, but cost only about half as much. At present, valves and fittings are suitable for 125 psi and 140 F.

In thicknesses of comparable strength, rigid pvc weighs about half as much as stainless steel. For a long list of organic and inorganic chemicals and reagents, this material exceeds stainless in its resistance to attack.

"Welding" of rigid pvc is possible by use of a hot-air torch and a plastic electrode. Similar processes permit using pvc as an internal liner for steel, iron and other piping. Since the plastic lining is not attacked by the liquid flowing through the pipe, the life of the steel or iron is increased considerably.

Studies show that rigid pvc is worth considering wherever castings of stainless steel, brass, bronze or similar alloys are used. It can cut costs and give lighter piping systems.

Latest PRACTICAL IDEAS *to help you do a*



Now, two centrifugal feed-pump problems are solved

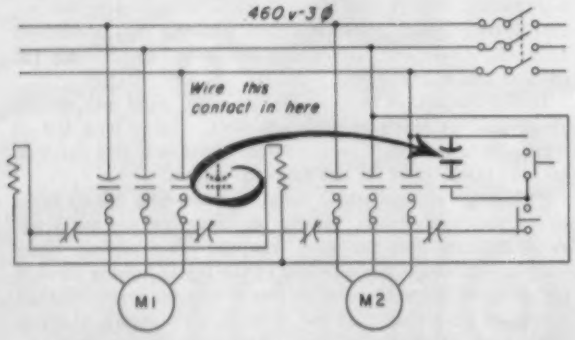
MAIN BEARING on one of our feed pumps gave trouble by overheating. Pump is a 4000-gpm centrifugal, with 720-ft head, 3500 rpm. Both bearings are roller type. Oiler at end, photo, feeds bearing by gravity.

After our first headache with this pump, I removed the ½-in. pipe plug in top of bearing and made a plug with small holes on sides to work as vent. That solved our bearing problem.

Second problem was from 220-F water at only 12-ft head, causing pump to be vaporbound. We ran a ¼-in. pipe of city water at 100 psi into the suction side. Valve is barely cracked, right photo. This cools water just enough to prevent flashing.

In year since making these two changes, our feed pump has run OK.

H LUDOVICI *Montreal, Que.*



I'd wire Ziemke's motor like this

MAGNETIC STARTERS drop out for a number of reasons besides the opening of the thermals. Why didn't Ziemke (p 134, Nov) wire the auxiliary contacts in series as I show in this sketch?

F J ARDALINO *Brooklyn, N. Y.*

Neon-tube tester for static electricity

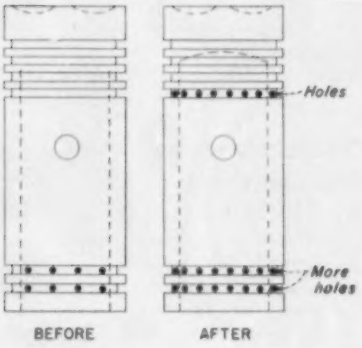
WE USE a common neon-tube tester (type for testing automobile spark plugs) to find static electricity. Tube glows when one lead is brought into contact with a body charged with static, whether or not the other lead is grounded. But this test cannot determine amount of charge.

CAUTION: If flammable vapors and explosive dusts are present, this tester may be dangerous. Reason is that static spark may jump from the object containing an accumulation of static to the lead of tester or operator. We don't have this dangerous condition and, therefore, it's safe in our plant.

P W OLSON *Mt. Vernon, Ill.*

better job and cut your costs

STEVE ELONKA, *Associate Editor*



We cut diesel lube oil to one-fifth

I'M IN CHARGE of one 95-hp 2-cyl 2-cycle 600-rpm diesel and one 120-hp 3-cyl 2-cycle 500-rpm engine, both on light service.

The 95-hp engine has been running ten years, but consumes one gallon of oil per 300 hphr, which is high. But liners and piston rings on the engine are OK. Oil consumption on our 120-hp engine is also high.

Not satisfied, I pulled pistons and checked piston rings and scraper rings. They were properly installed with minimum gap of .002 in. per in. diameter. I drilled holes through piston-ring groove of bottom ring set, sketch. Then I replaced ring with scraper ring in this groove. That diverts the scraped excess oil toward crankcase. Now oil consumption is one gallon per 1500 hphr, yet liners are properly lubricated.

Slight maintenance cost of making improvement is paying big dividends.

A CAMACHO *Cebu, P. I.*

Corrosion in centrifugal pumps

ELECTROLYTIC CORROSION often attacks centrifugal pumps because dissimilar metals are in contact with the water handled, which then acts as an electrolyte. This forms local currents. These may not be sufficient to cause serious corrosion but they do cause pitting, especially in bearings.

Remedy is to ground the pipe work of pump, and mount a slip ring on impeller shaft. Then connect carbon brush bearing to a ground. Ground must be perfect to handle any local currents.

W E WARNER
Woodford Green, Eng.

What would you have done?

COMING INTO THE FIRE ROOM one morning I found the cockeyed fireman was fast asleep on the "soft" coal pile. The boiler was a mess, with grates lying in the ashpit. The center support and grates around it were burned through.

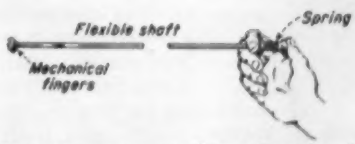
After cooling down (myself and boiler), we phoned for new grates. Because our boiler was ancient, we'd have to wait a few weeks until they were cast for us. But a shutdown was impossible, so I had to come up with a Marmy idea —and fast.

Grates were in a fore-and-aft position, supported in the center by a casting from side to side in furnace. I replaced this burned-out casting with an angle iron, supported underneath from one side of furnace to the other with firebrick. That wall made two pits in the furnace. I filled the back pit with ashes even with grate level. I covered the front pit with grates that I salvaged from that mess.

We fired up to 125 psi and I started putting on our engine and other loads. With all loads on, the boiler carried on fine—but the fire did need a little more attention. Yet boiler steamed better and, believe it or not, we cut coal consumption from between 3 and 4 tons a day to 2½ tons. That boiler was still fired with the jury-rigged grating five years later when I left the plant. What would you have done?

EMIL STARK *Brooklyn, N. Y.*

Here's what I'd do for HH's Dec headache



IF MECHANICS are working where there's a chance of dropping screws, bolts, etc, into recesses of machines that are hard to get at, they usually have a tool about 24 in. long, called the mechanical finger. I've had Holcombe's problem many times while in newspaper press rooms where the time element is important.

Tool shown should be in every plant.

B A CROSSON *Cranston, R. I.*

Why don't operators get efficiency bonus?

PRODUCTION PEOPLE often cash in on efficiency. Why don't power engineers come in for their share of this gravy?

Suppose a plant runs at 80% efficiency, then the power engineer ups this to 84%, saving large sums in a big plant. What kind of bonus system will justly reward him and his department? You readers who have such a system can get the ball rolling by sending me all details. I'll run your answers.—*Editor*

(*Continued on page* 138)

More PRACTICAL IDEAS

Begins on page 136

Here's your 'trick' of the month

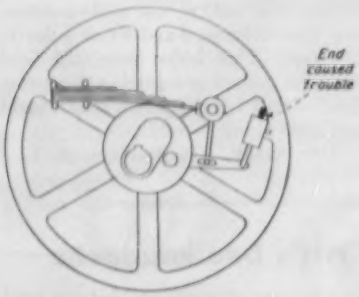
REMEMBER the old Keystone Cops 2-reeler comedy years ago? In one picture, the tin lizzie stalled. One cop got out, raised the hood, yanked out the engine and threw it away. Then he cranked the lizzie and drove off. Well, we solved a problem at our large modern brewery in just about the same way.

Our new 120,000-lb-per-hour boiler has watercooled walls. Six burners are the steam-atomizing type, boiler burns bunker-C oil. Oil pressure is from 50 to 150 psi. The six diffuser burner-cones burned out every week.

Diffusers, of high-content nickel-steel, cost $80 apiece. That ran our bill up to $480 a week, just for those new parts.

Burner tips extended 8 in. past wall into furnace, with diffusers fastened near end. We removed the diffusers and shortened burner barrels so the tips came about flush with wall. Now we not only have no shutdowns because of having to replace diffusers, but we also have no diffusers to worry about. If there's any difference in our combustion, we haven't noticed it in nine months.

W GEDDES *Montreal, Que.*



Watch governors of the inertia type

SHORTLY AFTER taking over my watch aboard ship the room steward called engine room, requesting heat to be cut off. While I closed the valve my oiler changed exhaust of dynamo engine and forced-draft blower to main condenser. Suddenly lights began to brighten, next they popped out, then we were in complete darkness.

Ship had no emergency-lighting equipment, but my ears told me the dynamo engine was really cutting loose. I groped my way to throttle. Governor was an inertia type, with a single weight mounted on end of a leaf spring, sketch. Movement of weight controlled eccentric throw. She had a gag pot connected into linkage to regulate the sensitivity.

I first released all tension on governor spring, next removed valve chest cover. Then I tried to swing weight through its normal travel range as oiler watched the valve. Weight moved freely until it was within ¼ in. of outer (no-load) stop, then I couldn't move it farther. "No wonder she kicked 'er tail over the dashboard when you put 'er on the vacuum," I told the oiler. "The valve should cover the admission ports completely at no load, but here it is with more than ⅛-in. lead!"

I unshipped the gag pot, then grasped governor linkage. It now swung freely from stop to stop.

I removed pot assembly, unscrewed bonnet, withdrew stem and piston. Stem had been threaded into piston, but a full ½ in. was protruding on back side. This shortened linkage travel by that amount, preventing governor from controlling the speed when on vacuum at light loads. But when on heating system, the added backpressure needed more cutoff so governor could maintain control.

I cut protruding end of stem off flush and peened it a little. Upon reassembly, linkage swung freely from stop to stop and the valve covered admission ports when governor was up against outer stop. Dynamo set was started and functioned perfectly under all conditions.

M A JENSEN *Lincoln, Neb.*

Guard for rising stem gate valves

WE HAVE VALVES around the engine room that should normally remain open. To guard against accidental closing, I remove handwheel, slip a piece of copper tubing over the stem. It's just long enough to prevent valve being closed. Then I replace handwheel. Valve can't be closed without removing tubing. Tubing can be split and clipped in place so it snapped on and off.

E R ECKERT *Fanwood, N. J.*

I don't agree with Greif

YOU'LL COME TO GRIEF if you follow L R Greif's idea of punching two nail holes in a paint-can rim to drain back, then after putting back cover expect paint not to skim over (p 154, Dec).

Sketches show my method. For a small can, I use a half cover from an old can to drag excess paint off brush. When through, I remove half cover, then placing small piece of rag over can I replace its cover and tap whole cover onto rag. This cleans groove. I seal can with cover and place it on shelf, cover side down. Every so often I turn my stock of cans over to resettle them.

Also, a 1-gallon rectangular can has a handy shape for large-size brush dipping. Cleaning or wiper rod keeps all paint in can, none runs over side. When finished, I return all excess paint to regular container, which won't be messed up because you have a real paint pot in this cut gallon-can. It can't be beat for handiness and safety if you're working on a ladder. Just hook it over a rung, and dip and paint away in any direction without losing your balance.

C H WILLEY *Penacook, N. H.*

(*Continued on page* 140)

NEW YORK STOCK EXCHANGE

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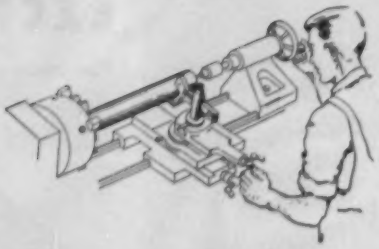
Mr. D. A. Kepler, Chief Engineer of the N.Y. Stock Exchange, in the photograph above, reports temperature is held within limits of approximately 1°F. plus or minus.

(a94)

Offices in Over 60 Cities **THE POWERS REGULATOR COMPANY** Established 1891

More PRACTICAL IDEAS

Begins on page 136



Centering tool restores damaged centers

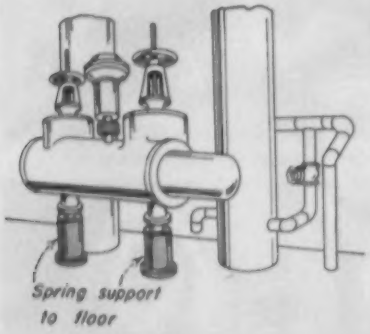
CENTERS IN SHAFT are often damaged. You can easily restore them to their original condition and location. Have your blacksmith split a piece of lathe tool-steel stock, horizontally, about 4 in. from end. Forge two prongs thus formed into a V, with about 75-degree angle included. Have center line of angle coincide with center line of tool.

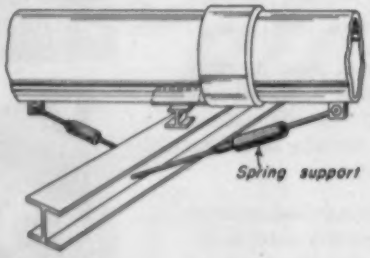
Usually you can find a "spot" on shaft near damaged center-end where original turned surface is untouched. Here original position is in true relation to work center.

Set up lathe tool so each prong just bears on top and bottom of the lathe tail center. Now, replace tail center with centering-drill held rigidly in tail stock. Place shaft in lathe chuck with damaged center resting on point of centering drill. Set V tool close to undamaged originally-turned shaft surface.

With lathe adjusted for medium speed, start it and feed both the forked tool and reamer lightly to the work at the same time. Drill will machine perfect work center in that end of shaft. Every lathe toolkit in maintenance shop should have one of these fork tools. My experience shows they are very valuable.

H B MCDERMID
Long Beach, Calif.





We licked a tough vibration problem

VIBRATION and pipe swaying, from reciprocating air compressors, loosened the insulation, shaking off big chunks. Hangers were loosened and structural supports endangered. Instrument lines and small piping vibrated, causing leaks. Then our controls started going haywire.

Cause was three steam-driven compressors, of variable speeds up to 125 rpm, but compressors did not vibrate on foundations. Effect was from three machines taking steam at same time from 180-psi header.

We licked the movement with spring hangers where expansion caused pipe to rise free of the various hangers.

Horizontal run was properly supported with a spring hanger, but did not prevent side sway. This dampened virbration some in branch, also prevented oscillation of branch that set up vibration in header itself.

We had to install stays and springs adjacent to building columns for a new 12-in. line that feeds steam for this 16-in. header. These stays and springs don't interfere with expansion and contraction.

Two vertical headers are also supported. Piping above headers has ears welded to pipe, with rods and attachments to building structure. This would support headers and horizontal piping, but would leave headers' bottoms and connecting pipe to move as a pendulum. So we installed spring supports to floor. Here expansion downward can take place and pipe still be supported from overhead. Two floor supports each sustain load of 2100 lb when lines are hot.

At times movement in one location would seem to increase instead of diminish by dampening movement at another location. Vibration and swaying in this area has been reduced. Result has been to greatly diminish sway and vibration in remote sections of piping in boiler plant. Instruments also work OK.

E H ROPER *Toledo, Ohio*

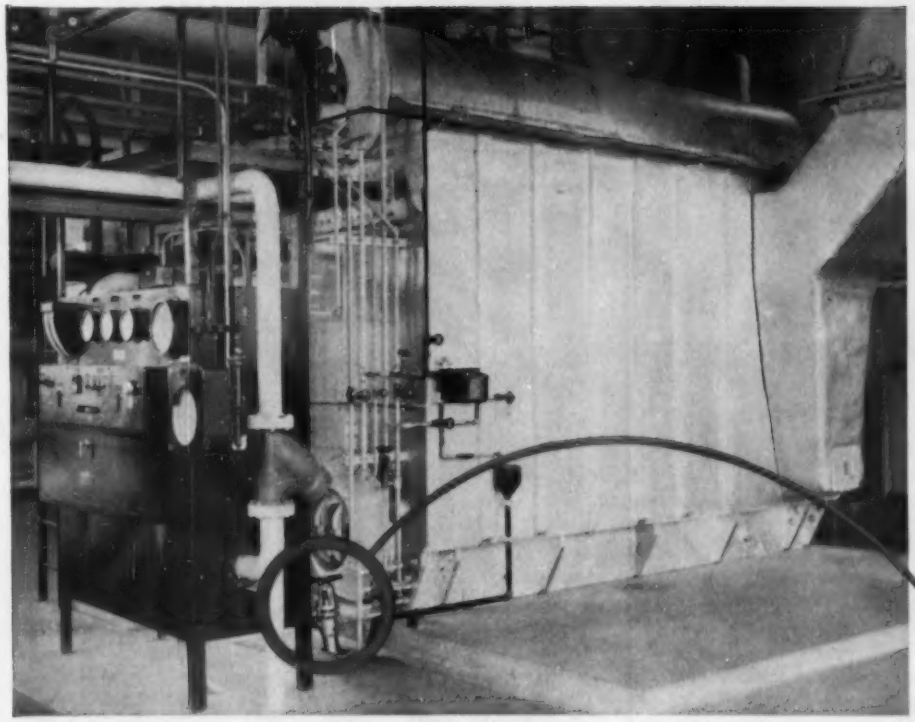
Now our air-compressor gages are centralized

WE HAVE a horizontal 1800-cfm motor-driven 300-hp 100-psi 2-stage air compressor. The high-pressure gage, intermediate gage and lube-oil gage were on three different sides of machine. We made one panel for the three, welded it to the intercooler, connected gages with copper tubing, photo. Now we get the complete story at one glance.

H LUDOVICI *Montreal, Que.*

1955 AWARD PROGRAM

Have you recently modernized any of your power services? Tell us about it. You may be in the 1955 award picture. See p 85



COMBUSTION ENGINEERING ADOPTS YARWAY SEATLESS BLOW-OFF VALVES FOR PACKAGE BOILERS

Combustion Engineering, Inc. on this package boiler installation at the Orangeburg Pipe Plant in California, again includes Yarway Seatless Blow-Off Valves as part of the "package."

It's a popular idea—and growing fast. All *good* package-type boiler installations are *better* when equipped with Yarway Seatless Blow-Off Valves.

More and more boilermakers are standardizing on Yarways, and more and more boiler users are expecting the advantages of Yarway Blow-Off Valves on their package units.

Get the full story on why more than 15,000 boiler plants use Yarway Blow-Off Valves, some for 30 to 40 years.

YARNALL-WARING COMPANY

100 Mermaid Avenue, Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES

Yarway Type "8" Seatless Tandem Blow-Off Valve. Note balanced sliding plunger design with no seat to score, wear, clog or leak. Pressures to 400 psi.

YARWAY BLOW-OFF VALVES

This actual PLANT PROBLEM *solved by*

The question

How can we keep outdoor lines from freezing?

THE FACTS: We're building a plant in the colder part of Canada where we're faced with the problem of adequately protecting long outdoor runs of fuel-oil, chemical, water, air and process piping. We want to avoid the dangers of freezing a line.

Steam will be available for tracing these lines, but right now we're wondering what is the best way of tracing lines like those listed above. Run between power plant and other buildings varies from a few hundred feet to about one mile or more.

Which is best—prefabricated pipe containing built-in tracers, or regular pipe with an extra line for tracing? How is condensate from tracer handled? Is there any relation between tracer size and pipe size? Is electricity more practical than steam for tracing?

—GT, Dec Power

The answers →

I: Effect of wind velocity on heat-loss rate

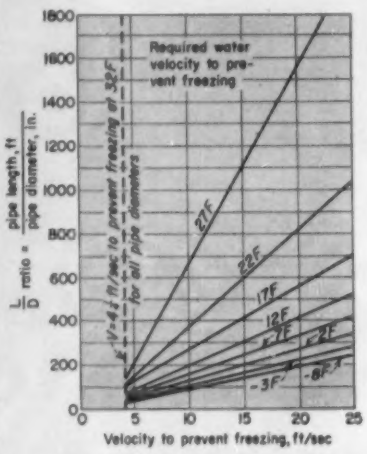
Ratio of actual heat losses to still-air heat losses, bare or insulated surfaces

Wind velocity,	Temperature difference between exposed surface and air, F								
mph,	100	200	300	400	500	600	700	800	900
2½	1.46	1.43	1.40	1.36	1.32	1.27	1.22	1.17	1.12
5	1.74	1.69	1.64	1.59	1.53	1.47	1.38	1.29	1.20
10	2.16	2.10	2.02	1.93	1.84	1.72	1.59	1.45	1.31
15	2.50	2.42	2.33	2.21	2.08	1.94	1.77	1.60	1.44
20	2.76	2.69	2.58	2.45	2.30	2.14	1.94	1.75	1.54
25	2.98	2.89	2.78	2.64	2.49	2.30	2.10	1.90	1.65
30	3.15	3.06	2.94	2.81	2.66	2.46	2.25	2.02	1.77
35	3.30	3.21	3.10	2.97	2.81	2.61	2.40	2.15	1.90

II: Time to freeze water

In uncovered pipes, minus 8-F air temp; water not flowing

Nominal pipe size, in.	Freezing time, hr
4	24
6	36
8	49
10	61
12	72



Heat-loss rate, fluid properties and wind velocity set tracer size

Tracer size depends on heat-loss rate for the pipeline, freezing temperature, heat of fusion for the fluid, and local wind velocity. Also, flowing water does not freeze except at extremely low temperatures. Experience shows, for example, that water flowing at 4.25 ft per sec does not freeze in an unprotected line at 32 F. Graph above plots minimum water velocities to prevent freezing vs pipe characteristics.

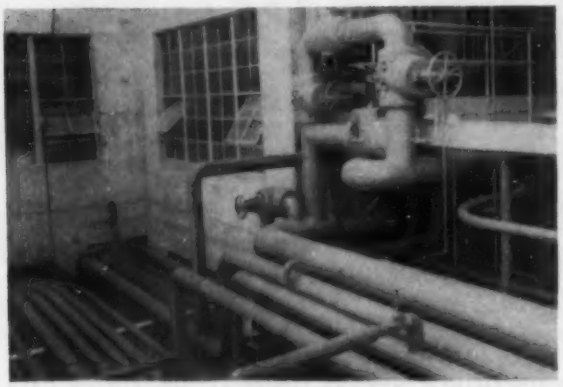
Table II gives required time to freeze still water in uninsulated lines at minus 8 F. For insulated lines, heat-loss rate can be figured based on average temperature difference between fluid and outside air. Insulation manufacturers' catalogs give such data. Factor for effect of wind velocity must be applied to the estimated still-air heat loss to get actual heat loss. This information is given in table I above.

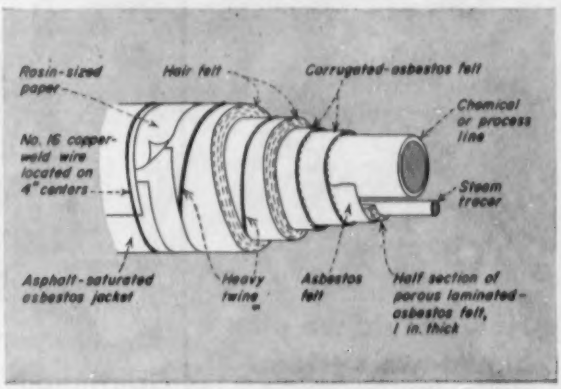
From these calculations *GT* can get freezing time and decide where he wants steam tracers. Knowing necessary heat input to prevent freezing and heat available from steam, pipe size can be selected. ¾-in. pipe is recommended minimum for structural stability. Superheated-steam use is best for long outdoor lines to avoid excessive condensation.

H B Wayne — *Brooklyn, N. Y.*

our readers may be your problem too

HOWARD KALLEN, *Assistant Editor*





This outdoor piping can be protected by steam or electricity

Short air lines for instruments, as well as short runs between buildings, can be handled effectively with standard electric heating cables. Another method not to be overlooked is passing low-voltage current through the piping itself.

Where fuel-oil lines run from a storage tank remote to the plant, steam coils will probably be installed in the tank. Here, steam-supply and return lines can be banded together with fuel-oil piping in one insulated run.

Choice of closed or open system for condensate often depends on relative scarcity of water. In some areas condensate can be returned to a gathering system. But in many cold and isolated locations free discharge is best way to dispose of condensate from a steam-tracing system.

E F WEHLAGE *Fairport, N. Y.*

How to insulate pipe and tracer

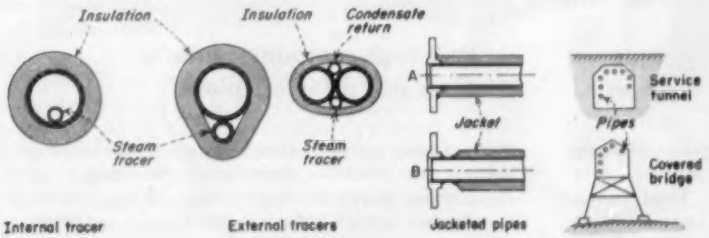
GT's piping systems located underground can be protected with a small-diameter low-pressure steam line running next to the pipe and properly insulated, as shown in sketch above.

Tracing with electrical heating cables is most practical on short runs. On long underground runs the heating would have to be installed in sections, each having its own control thermostat. This arrangement becomes expensive.

Air should pass through dryers before it is discharged to outdoor lines. And all systems are pitched to drain within building areas for operating convenience.

If lines being traced are longer than 200 ft, manholes or recesses should be made in the ground to permit installing a trap for the steam line. Discharge the trap into the pit, providing a trap-rock floor. One-inch tracer size is adequate for main lines to six inches; 1½ inches for 8-inch pipe and up.

A J BREUGELMANS *New York, N. Y.*



Internal tracing is most efficient

From a thermal viewpoint internal tracing is most effective. Since the tracer wall is in direct contact with pipe fluid it can quickly thaw fluid enough to allow pump startup. Also, this type is most economical, permitting use of standard prefabricated pipe covering. Caution: Tracer pipe must be thoroughly tested for leaks during erection and provision made for thermal expansion. Don't use this type where possible steam leak may contaminate fluid. External tracers shown above avoid this hazard but are less effective.

Jacketed pipes can be used for severe conditions that tracers can't handle and where electrical heating is not economical. Type *B* above is an improvement over type *A* since steam can't leak into the pipe at flange joint.

Trap low points along tracer

Low points along the steam tracer should be trapped. To reduce possibility of freezeup, use a bellows or impulse-type trap. Condensate may be returned if steam piping is not connected to tubular oil-heating units. Such a heater could contaminate condensate if not in perfect condition.

D J CRAIG *Somerville, N. J.*

Service tunnels or covered pipe bridges, shown above, are a practical solution when a large number of lines can be grouped together on a run of a few hundred feet. This applies mainly to locations where frequent winter storms interfere with maintenance and inspection of piping systems.

I. G MATHYS *Montreal, Can.*

(*Continued on page* 208)

For blowdown-system study and your new questions, turn page ►

Another PLANT PROBLEM solved by readers

Begins on page 142

The question

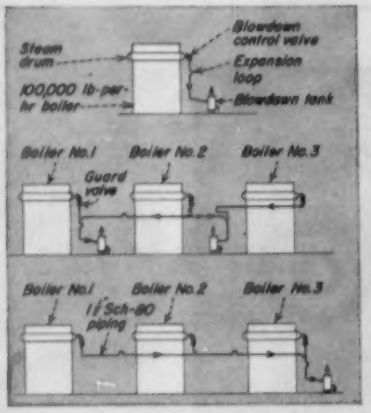
How should we plan blowdown system?

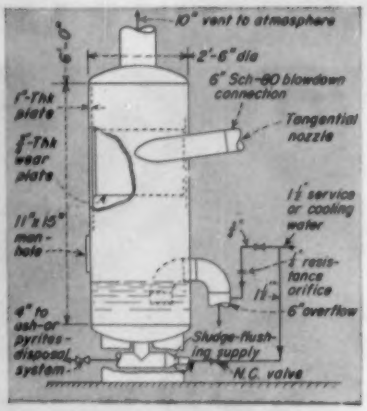
THE FACTS: We have three 100,000-lb-per-hr boilers to which we must fit blowdown tanks to protect a new sewer system from flash. Our local laws do not have any specific requirements for tank design other than suitability for plant conditions. These boilers operate at 900 psig, 750 F.

What is best hookup for this type installation? Should a single tank be used or are three better—one for each boiler? What are good pipe layouts for tanks? Can heat be recovered?

—MS, Dec Power

The answers





Continuous blowdown yields operating dividends

For 900-psig boilers in *MS's* steam plant the maximum permissible solids concentration in boiler water is 1500 ppm. Manufacturers do not guarantee steam quality and purity beyond this figure (see ABMA standards).

Continuous blowdown originating just below water level in steam drum removes the greatest quantity of solids since concentration is highest here. Advantages of continuous blowdown are: (1) Operation is automatic. (2) Heat is recovered economically. (3) Uniform solids concentration can be maintained.

Possible installation arrangements are shown above, left. ASME Boiler Code requires a guard valve when lines from more than one boiler are hooked to a common header. Also, avoid pockets or drain them continuously to a lower point, either in system or to waste.

Blowdown-tank design, above right, is in accordance with ASME Unfired Pressure Vessel Code. To prevent water flashing in the sump or sewer, a cooling line is connected to the overflow to absorb excess heat. At tank bottom a sludge-removal connection, with a supply of service water, is used to eject the sludge concentration at regular intervals. Don't flush sludge to a sump where it must be removed manually.

A J Breugelmans *New York, N.Y.*

(*Continued on page* 146)

YOUR MARCH PROBLEMS

1 How can we maintain constant steam pressure with sudden load changes?

New process in our chemical plant requires 300-psig steam. Its nature is such that steam load can vary between 5000 and 10,000 lb per hr. Load swings are rapid and the process can tolerate little deviation from 300 psig. Automatic controls include a steam-pressure-responsive proportional controller that sends an air signal to the 600/300-psig reducing valve in the process-steam-supply line.

Our chemical engineers complain that steam pressure strays outside acceptable limits when load jumps or drops off suddenly due to a process change.

I've heard about control systems that are supposed to solve problems of this type—with automatic compensating features, but am not sure this is the answer. Would a positioner on the reducing valve help? How would such a system be hooked up?—*AW*

2 Will high-rupturing-capacity fuses pay off in my plant?

We're facing up to a dangerous electrical condition because our available short-circuit current has outstepped our circuit-breaker ratings. In brief, incoming feeders are 13.2 kv, trimmed down to 2300 v for plant distribution. Total load is about 7000 kva. The local utility can now supply far and above the original available short-circuit kva over any of the feeders to our plant. This means that our present circuit breakers couldn't safely interrupt a solid short circuit if one occurred.

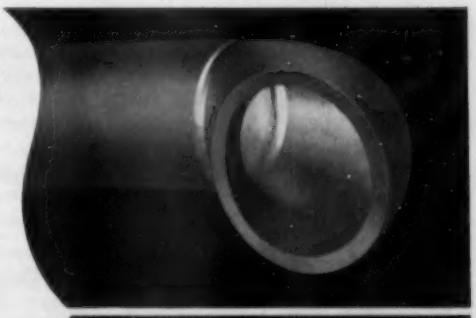
Since we can't sell top management on a new switch-gear installation, can we safely use the high-rupturing-capacity type fuse to back up existing circuit breakers? Or, can we get replacement circuit-breaker units without buying completely new switchgear?—*SJ*

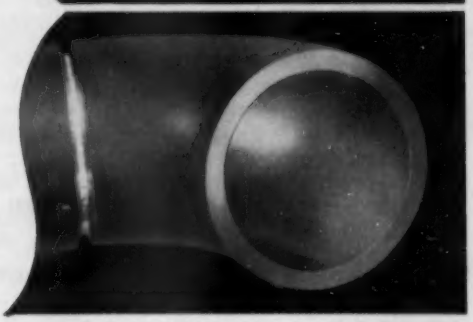
Send your answers to Plant Problems Editor. Extra pay for photos, sketches.

INERT GAS TUNGSTEN ARC-WELDING
ON HIGH-TEMPERATURE, HIGH-PRESSURE PIPING

It's More a Matter of Skill Than Inert Gas Back Pressure

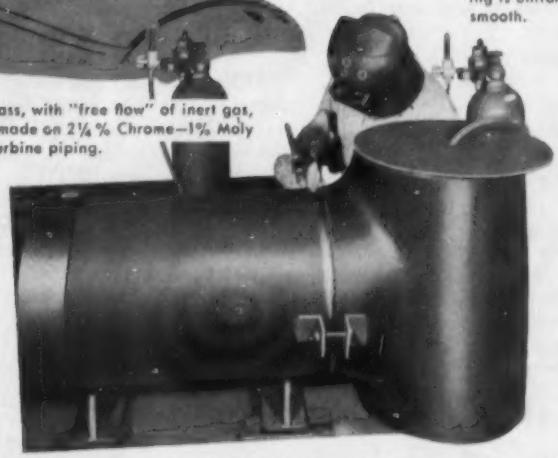
Inside bead surface of root pass on 2¼% Chrome—1% Moly steel turbine connection produced by P.P.&E. inert gas tungsten arc-welding is uniform and smooth.





Typical external surface of root pass produced by skillful inert gas tungsten arc-welder.

Root pass, with "free flow" of inert gas, being made on 2¼% Chrome—1% Moly steel turbine piping.



Inert gas tungsten arc-welding is one of many operations involved in the fabrication of high-temperature, high-pressure piping. Like the others its success is not assured by a single factor, but comes as a result of long experience with all manufacturing techniques and service requirements of power piping.

Simply protecting the internal surface of the root bead with inert gas under "control" does not take the place, for example, of skillful welding.

Pittsburgh Piping's process provides an inert gas shield against the atmosphere on both internal and external surfaces of the root pass. This procedure, combined with other P.P.&E. techniques, eliminates need for backing rings and double butt welding, and produces a sound, clean joint having a remarkably uniform root bead of correct internal contour.

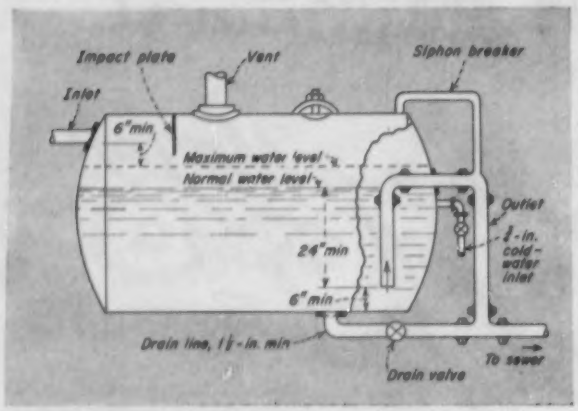
Applicable to all types of power and process piping—inert gas tungsten arc-welding is another of the many advanced P.P.&E. techniques used in producing all types of power piping —as small as control lines, as large as steam mains.

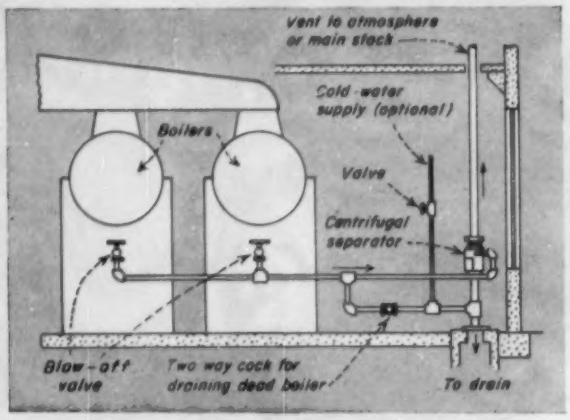
Pittsburgh Piping
AND EQUIPMENT COMPANY
10 Forty-Third Street—Pittsburgh, Penna.

Atlanta.....Whitehead Building	Cleveland...Public Square Building
Boston.....10 High Street	Houston...Heights State Bank Bldg.
Charlotte.....221 Builders Building	Los Angeles.1830 N. Alexandria Ave.
Chicago.....Peoples Gas Building	New Orleans.....P. O. Box 74
New York.....Woolworth Building	

PP-5

Begins on page 142





Consider these design tips for blowdown systems

First step is to check municipal, county or state codes since authorities consider steam, or even hot water, a danger to vitrified-clay sewer pipe.

Main functions of a blowdown tank are to: (1) reduce hot boiler-water discharge pressure to atmospheric and separate flash steam (2) dispose of the water as is, or at reduced temperature (3) dispose of flash steam. Where one blowdown tank serves two or more boilers, blowdown schedule must be carefully timed to avoid overloading the tank. During an emergency; for instance, if boiler-water level is high, immediate blowdown could exceed tank capacity—spouting steam and water from the vent and sending excessively hot water to the sewer. Point in favor of one tank: Cooler water from previous blowdown helps to absorb heat from the present one.

Blowdown tanks should be sized so discharge water is reasonably cool when blowdown period ceases. Here are recommendations:

Boiler output	*Size in inches*		
lb per hr	*Tank*	*Outlet*	*Vent*
8700-21,000	42-d x 60-lg	5	6
Over 21,000	48-d x 72-lg	6	6

Never allow inlet to become submerged. A vacuum could develop causing flow reversal. As in the sketch, above left, the inlet should always be at least 6 in. higher than the maximum water level in the tank.

Discharge-line flow area is twice that of inlet—or more. Also, don't overlook siphon breaker to keep tank from draining itself due to siphoning action.

Some high-pressure plants use a centrifugal blowdown separator, above, right. Separator allows the steam to pass off quietly through a vent, while water and sludge flow to a chamber below the separator. Manufacturer claims that sewer-water temperature for such a system is not excessive.

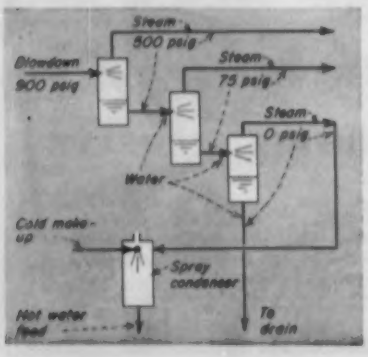
F Ptacek *Yarnall-Waring Co*
E Finsel *Philadelphia, Pa.*

How to design a 3-stage blowdown system

Assuming that *MS* can use 500, 75 and zero-psig steam, here is a design for heat recovery from 1% continuous blowdown.

Steam-table data:

Press., psig	900	500	75	zero
Sat. water, Btu/lb	529	453	290	180
Sat. steam, Btu/lb	——	1204	1185	1150



(1) Continuous blowdown:
0.01(300,000 lb/hr) = 3000 lb/hr

(2) 500-psig flash steam:
3000(529–453) ÷ (1204–453) = 304 lb/hr
304(1204) = 366,000 Btu per hr

(3) 75-psig flash steam:
2697(453–290) ÷ (1185–290) = 491 lb/hr
491(1185) = 582,000 Btu/hr

(4) 0-psig flash steam:
2206(290–180) ÷ (1150–180) = 250 lb/hr
250(1150) = 288,000 lb per hr

(5) Water to sewer:
3000 –304 –491 –250 = 1955 lb/hr
1955(180) = 352,000 Btu/hr

(6) Makeup required at 80 F, 48 Btu/lb, to condense zero-psig steam to water at 180 F, 148 Btu/lb:
250(1150) ÷ W(48) = (250 + W)148
W = 2510 lb/hr, or 302 gal per hr
Size makeup line for 400 gph to take care of peak loads

(7) Flash-tank size:
Upper limit of tank sectional area is based on following rule: Steam that can be flashed without undue carryover, in lb per sq ft per hr, equals 3 x tank pressure, psia.

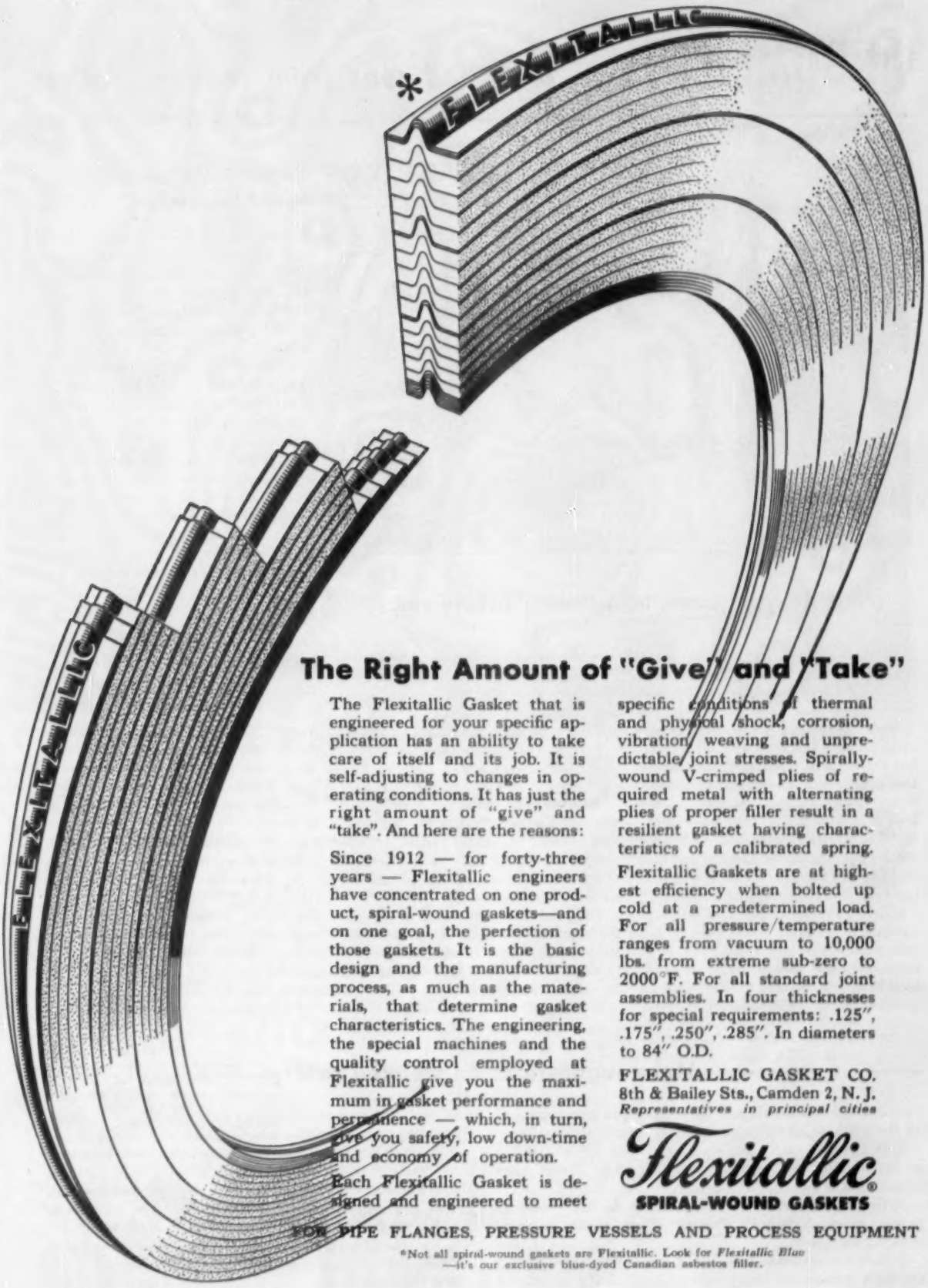
For 500-psig tank:
304 ÷ (3 x 515) = 0.2 sq ft

For 75-psig tank:
491 ÷ (3 x 90) = 1.8 sq ft

(*Continued on page* 210)

1955 AWARD PROGRAM

Have you recently modernized any of your power services? Tell us about it. You may be in the 1955 award picture. See p 85



The Right Amount of "Give" and "Take"

The Flexitallic Gasket that is engineered for your specific application has an ability to take care of itself and its job. It is self-adjusting to changes in operating conditions. It has just the right amount of "give" and "take". And here are the reasons:

Since 1912 — for forty-three years — Flexitallic engineers have concentrated on one product, spiral-wound gaskets—and on one goal, the perfection of those gaskets. It is the basic design and the manufacturing process, as much as the materials, that determine gasket characteristics. The engineering, the special machines and the quality control employed at Flexitallic give you the maximum in gasket performance and permanence — which, in turn, give you safety, low down-time and economy of operation.

Each Flexitallic Gasket is designed and engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler result in a resilient gasket having characteristics of a calibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs. from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". In diameters to 84" O.D.

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SPIRAL-WOUND GASKETS

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*Not all spiral-wound gaskets are Flexitallic. Look for *Flexitallic Blue* —it's our exclusive blue-dyed Canadian asbestos filler.

ARGUMENTS . . . *pros and cons from readers' letters*

ALTHEA THORNTON, *Assistant Editor*

To eliminate mechanical speed increasers?

READER MILLER (p 138, January) is correct. Siemens Schuckert made a motor within a motor (frequency changer) similar to a rotary converter, to obtain 6000 rpm at 50-cycle input for high-speed woodworking machinery.

Needless to say, the change in speed per cycle is greater with a 2-pole motor than with a 4-pole unit. Of course, frequency changes can be accomplished with either rotary or static devices, to obtain very high speeds. For economical or technical reasons, the manufacturers use speed-increasing gears for large-hp motors instead of frequency-changing equipment. Perhaps some day we shall see fit to eliminate the mechanical speed increasers that are now so common.

CARL BACHMANN *Rego Park, N. Y.*

What do you mean, no welding safety rules?

THE STATEMENT "there are no safety regulations for welders" (December "Practical Ideas") represents a state of mind rather than a correct conclusion.

Most manufacturers of such equipment prepare and keep up-to-date booklets for welders, covering recommended safe practices in cutting and welding.

American Welding Society is the leader in this field. They have sponsored an American Standard AWS-ASA Z49.1-1950, "Safety in Electric and Gas Welding and Cutting Operations," which has been widely distributed in industry. I believe I can speak for most welding-equipment manufacturers when I say that whatever safety regulations have been developed over a period of years have been passed along to the American Welding Society and, in turn, to ASA for incorporating into standard Z49.1.

These are recommendations only, but they have been the basis for local codes and ordinances referring to Z49 for guidance in specifying safe practices.

F C SAACKE, *Safety Director*
Air Reduction Co, New York, N. Y.

Because of my error, the opening sentence of the item "Safety for Welders" (December "Practical Ideas") was wrong. It should have read "Because there are strict safety regulations for welders, I'm suggesting . . ."

The readers who objected to my saying there are no safety regulations for welders are right. It would be wrong to think that a skill like welding had no rules to promote safety.

R KEMBEL *Bethlehem, Pa.*

Don't need engineer for unfired boiler

REGARDING Bert Richards' letter (December "Arguments") about my item in August "Practical Ideas," let me say first that I was an observer. The incident took place in a cannery about 18 years ago. Boilers were gas fired; all fires including the pilot lights were shut off at 6 pm, relighted at 7 am when the engineer came back on duty. Pressure dropped during the night.

In Minnesota we have *had* rather rigid license laws for about 30 years. But I can't find anything requiring an engineer to take charge of an unfired boiler. Incidentally, Minnesota has adopted the ASME Code as part of its law in regard to boilers.

C TRETINYAK *Rochester, Minn.*

More suggestions on welding safety

I BELIEVE *Kembel* should add the following to his suggestions on electric welding safety (December "Practical Ideas").

1. If possible, shield the work so eyes of welder's helper or anyone standing nearby are not affected by flashes when welder strikes an arc.

2. Ground the frame of any portable electric welder to prevent shock. Switch for shutting off unit should be on or near the equipment.

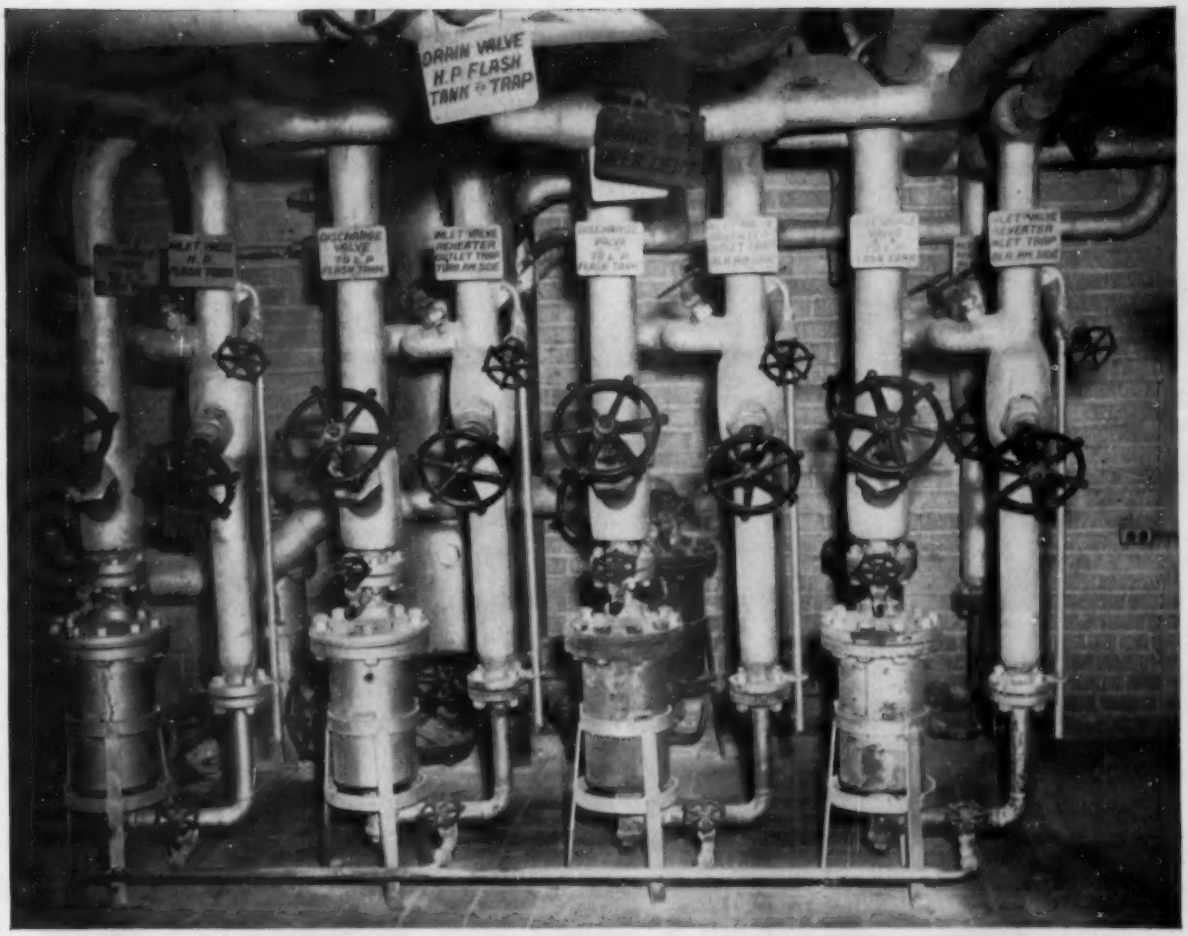
3. Insulate electrode holder and connecting cable. Don't use light holders for heavy work. Check electrical connections and insulation on the holders and cable at regular times. Have competent electrician make repairs.

4. Keep cables in an orderly arrangement, away from any place where they could be damaged, and out of the way of people and vehicles. Be sure they are dry and free from oil, grease and water. Put the electrode stubs in containers.

5. Keep hand-operated fire extinguishers close by.

6. Provide first aid for anyone suffering from "eye flash" injuries. Instruct the men to get treatment promptly.

B A CROSSON *Cranston, R. I.*



"Panel" of Eleven says Traps are Best for draining Superheated Steam Lines

. . . AND THESE PLANTS AGREE

Typical Armstrong high pressure trap users:

Consumers Power Company—
Comstock, Erie, Essexville, Muskegon, Zelwaukee, Michigan

Ohio Power Company, Philo, Ohio

Kansas City Power & Light—
Kansas City, Mo.

Georgia Power Company—
Yates, Macon, McManus, Georgia

United Illuminating Company—
New Haven, Conn.

Philadelphia Gas & Electric—
Philadelphia, Pa.

San Diego Gas & Electric—
San Diego, Calif.

Wisconsin Electric Power Company, Milwaukee, Wisconsin

Northern States Power Company—
St. Paul, Granite Falls, Black Dog, Minn.

Cincinnati Gas & Electric Company, Cincinnati, Ohio

One of the readers of a power plant publication recently asked, "which is the best device for removing condensate from lines carrying superheated steam . . ."

Eleven readers answerd this published question. *All* agreed, from experience, that steam traps are best.

Traps are automatic. Traps prevent steam loss. Traps take care of boiler carryover. Traps are available with sufficient capacity to take care of any condensate load. Traps don't "forget" to drain the lines.

Since 1929, Armstrong inverted bucket forged steel steam traps have kept pace with the trend to higher steam pressures. Today, they are widely recognized as essential safety devices in leading power plants throughout the world operating at pressures up to 2400 psig.

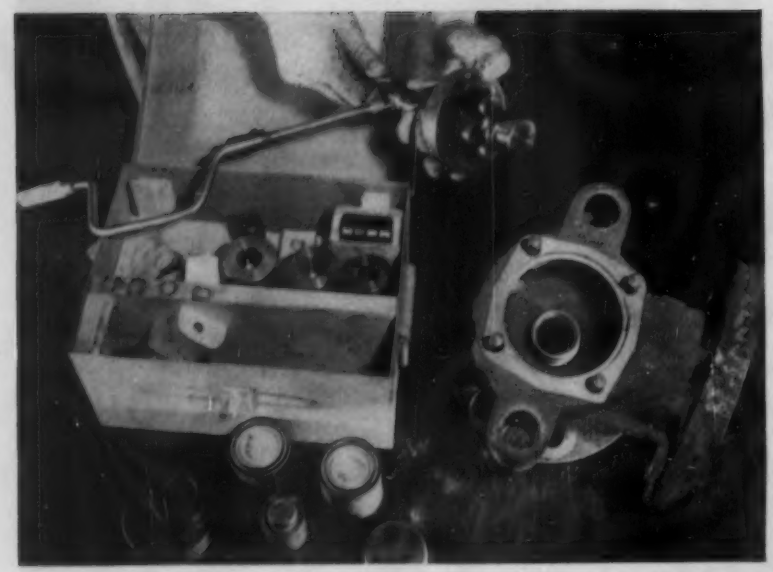
For safe, dependable drainage of superheated steam lines, get the facts about Armstrong traps. Call your local Armstrong Representative or write Armstrong Machine Works, 812 Maple St., Three Rivers, Michigan.

ASK FOR REPRINT—

"Should We Trap Superheated Steam Lines"—tells the experience of trap users . . . answers your questions on high pressure trapping. Ask for Catalog J, too . . . complete data on Armstrong forged steel traps. Free on request—no obligation.

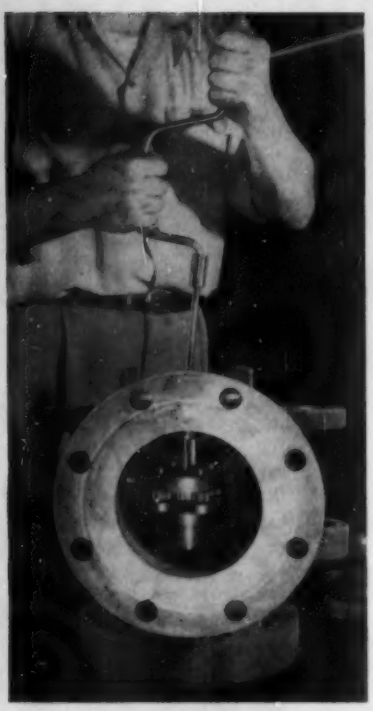
Application Engineered

ARMSTRONG STEAM TRAPS



1 Select right size plug to fit into valve nozzle as a guide; then place lapping disks with their planetary gears in tool body. Tighten into place with wrench

2 Place the guide plug in nozzle bore as here and coat the lapping disks with abrasive compound. Slip tool over guide and you're ready to grind in the nozzle



3 Crank away, keeping an even pressure against tool. Rotating disks do rest

HOW TO lap your safety-valve seats quickly

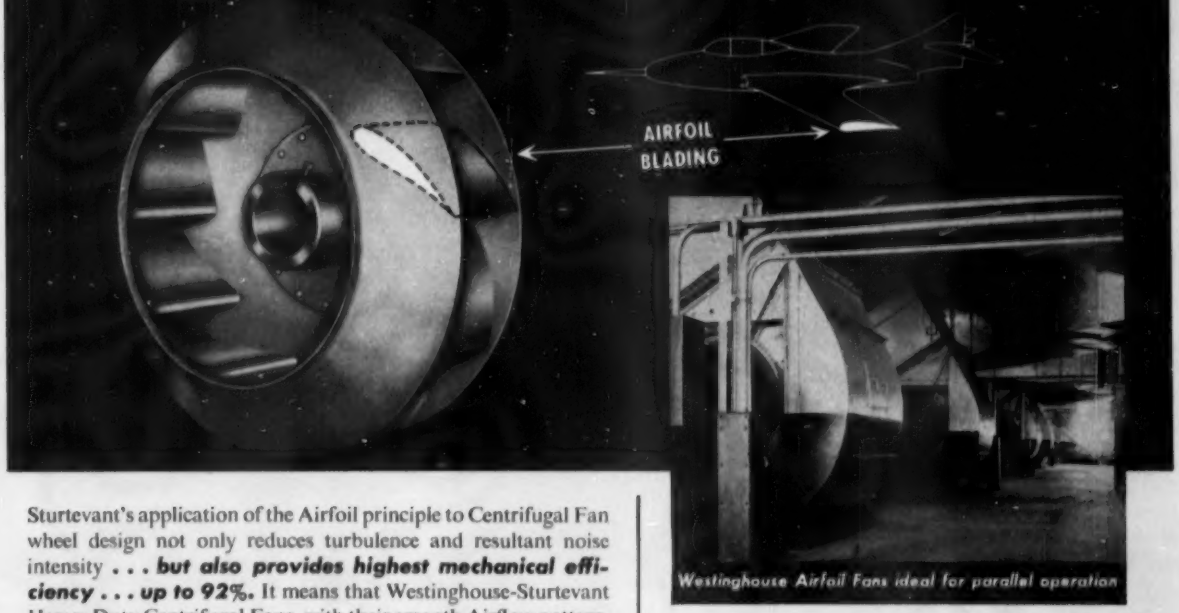
► HERE'S A NEW LAPPING TOOL for safety valves that restores valve seats in a fraction of time it takes to hand-lap. To adapt tool to several nozzle sizes, you can use correct size plug and laps that come in this kit. Lapping compounds and hand laps for touching up the seating surface of disks are all included in set.

When tool is set up as shown and crank turned, the four lapping disks not only rotate about their own axes, but also about the axis of plug, or center line of the nozzle's bore. Because laps work on planetary principle, they keep themselves in shape. Kit shown is good for five nozzle sizes. It's light enough for mechanic to carry on top of boiler to job.

—Courtesy: Manning, Maxwell & Moore, Inc

Fact:

WESTINGHOUSE FANS WITH AIRFOIL BLADING REDUCE NOISE INTENSITY 65%



Westinghouse Airfoil Fans ideal for parallel operation

Sturtevant's application of the Airfoil principle to Centrifugal Fan wheel design not only reduces turbulence and resultant noise intensity ***. . . but also provides highest mechanical efficiency . . . up to 92%.*** It means that Westinghouse-Sturtevant Heavy-Duty Centrifugal Fans, with their smooth Airflow pattern, operate at lowest cost.

FACT: *They are the most economical Centrifugal Fans you can select for power generation.*

1. Original Westinghouse Airfoil blading assures true, non-overloading horsepower. 2. Self-limiting horsepower characteristic reaches its maximum in normal range of selection. 3. Wheel proportions of Airfoil non-overloading fans facilitate direct connection to conventional squirrel cage induction motors.

The country's leading utilities have installed Westinghouse-Sturtevant Airfoil Mechanical Draft Fans to benefit from advanced design . . . lower operating costs . . . quieter operation.

MORE FACTS? Call your nearest Westinghouse-Sturtevant Sales Engineer . . . he's the "Man With The Facts" . . . or fill in the coupon below.

These and other leading Utilities have selected Westinghouse Airfoil Fans:

- Consolidated Edison, New York
- Duke Power Company
- Pennsylvania Electric Company
- Tennessee Valley Authority
- Southern California Edison Co.
- Philadelphia Electric Company
- Delaware Power & Light Company
- Cincinnati Gas & Electric Company
- Indiana-Kentucky Electric Corp.
- Ohio Valley Electric Corporation
- Duquesne Light Company
- New York State Electric & Gas Company
- Consumer Power Company
- Cleveland Electric Illuminating Co.
- Public Service Company of Indiana

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COMPANY .....

CITY ..... STATE .....

BASICS . . . *bringing engineering theory down to earth*

TOD WALDRON, *Assistant Editor*

How fuels burn-3

► IN THE LAST TWO BASICS, we spoke of combustion as a simple process—just the right amount of air completely mixed with gas, and the mixture heated and burned in one operation. This seldom happens in actual practice. Closest we get to it is in the gas engine. Here, near-perfect mixture is heated by compression and is ignited by a spark. Too rich or too lean a mixture will not ignite and burn.

On the other hand, mixing air and gas streams in a boiler furnace does not come so easy. And how this mixing is done makes a great deal of difference in the *nature* and completeness of combustion.

Blue-flame burning. To see how one form of combustion works, let's go back to our characters of last month. Since fuel must be or become a gas before it burns, we will talk about a simple hydrocarbon gas in our example.

Suppose we have methane accompanied by just the right amount of oxygen for combustion, and we raise the temperature slowly until it ignites and burns. We know this gives water and carbon dioxide and release of heat.

But what happens in between? If the burning takes place as a simple combination of oxygen and methane to form the products, then the two molecules of oxygen must collide with the methane molecule at the same time. (Or, take a rather absurd example—heptane, C_7H_{16}. Here 11 molecules of oxygen must collide with the gas molecule at the same instant. The odds against this happening are terrific.)

What really happens, then? Slowly heated hydrocarbons are oxygenated, forming intermediate products on the way to complete combustion. In this manner, all the oxygen is not needed at the same time.

The Bunsen burner is a good example of this type of burning. Here primary air mixes with gas at the base of the burner and the mixture is heated slowly so oxygenation occurs. Additional secondary air feeds the flame to give complete combustion. It is blue and nonluminous.

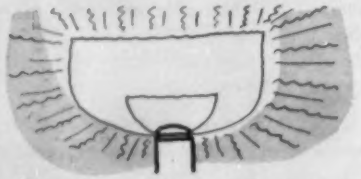
Different names are given this type of burning. We will call it simply blue-flame combustion.

Yellow-flame burning. Suppose we don't get good mixing of gas and air to start with. Or that the hydrocarbon gas fuel is subjected to high heat before it is oxygenated. Then a completely different type of burning takes place.

Let's see what happens in this type of combustion. Suppose we have a layer of methane next to a layer of air, and a mixing of the two only at the boundary. Now we raise the temperature at the boundary so we get burning. Then heat from this combustion causes our oxygen-starved methane molecules to crack. This cracking, or thermal decomposition, results in the methane breaking down into carbon and hydrogen.

Hydrocarbon molecules more complex than methane crack to smaller and smaller molecules until they also finally wind up in their basic form, hydrogen and carbon. Then when oxygen is available, the hydrogen burns, and the carbon glows as it burns, making the flame yellow and highly visible (termed a luminous flame).

We find this type of burning in the fishtail burner. Cold gas flows through a slotted opening in a thin flat stream. Nonburning area near tip is cold gas in process of picking up and mixing slightly with air. When flammable mixture is reached, and temperature is right, burning starts. Gas forming too lean a mixture begins to crack from heat of flame.



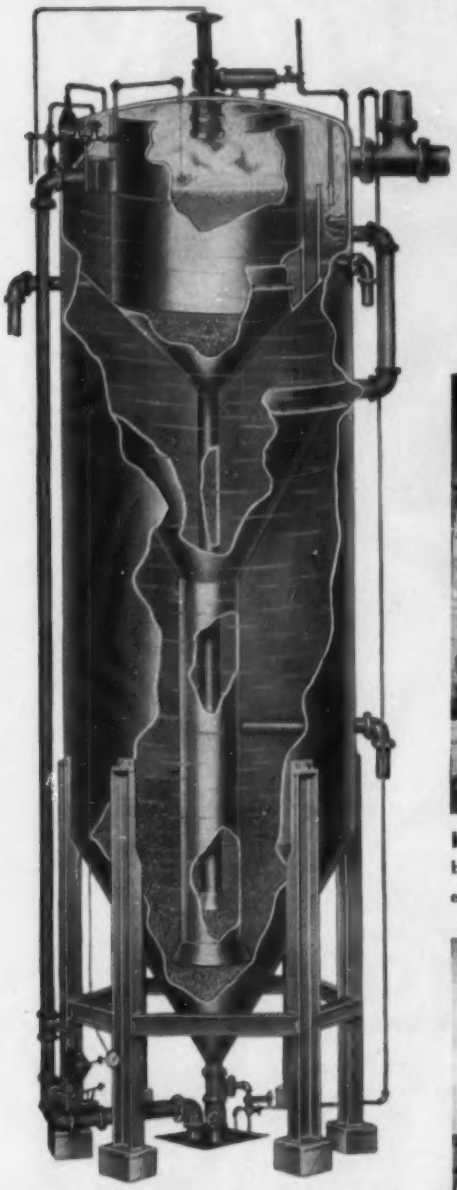
Normally carbon burns out pretty well by the time it reaches the flame edge. But if we put any cold object in the flame, the carbon particles are chilled and burning stops. Resulting deposit of lampblack or soot is identical with similar deposits in boilers. If these microscopic carbon particles are chilled so burning stops while the particles are still suspended in the products of combustion, we get smoke.

Here again, this type of burning goes by different names. We will call it yellow-flame combustion.

Combination. In practice, burning takes place as a combination of blue- and yellow-flame combustion. Which one should get the upper hand depends on the application. The yellow flame gives far more heat radiation, but makes smoky flame possible. The blue flame is long because of low rate of combustion; the yellow flame, on the other hand, may be short and hot.

In Hot Process Softening, too

BELCO Builds a Complete Line-



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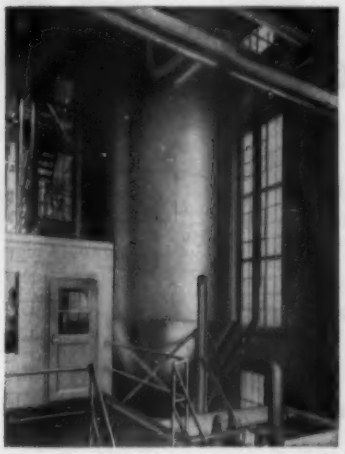
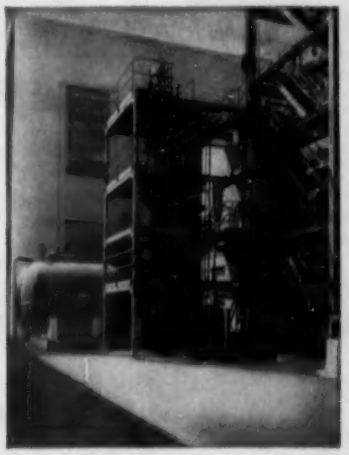
Belco

Processes for Removal of Water Impurities

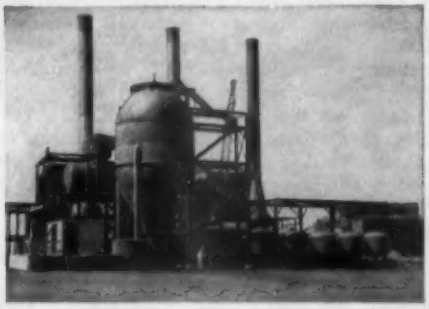
Belco-designed equipment provides high operating efficiency at low operating costs. Many of the country's largest industries rely on Belco for their water conditioning equipment. For example, Belco has built the largest fully automatic demineralization plant in the world and is currently furnishing one of the largest hot lime zeolite installations. A consultation with Belco could lead to lower operating costs for you, too. Write or call for technical assistance at any time.



HOT LIME SODA — Installation in boiler house at large eastern oil refinery. Has capacity of 200,000 lbs/hr.



HOT LIME SODA — Installation in large southwestern utility. One of three units with 90,000 lbs/hr total capacity.



HOT LIME BELCOLITE — Installation at large southern chemical company. Capacity 600,000 lbs/hr. This plant embodies "thoroughfare" operation of separate deaerator and hot process tank. The large hot process tank was designed, built and erected by Belco under its contract with customer.

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BELCO DESIGNS, ENGINEERS & FABRICATES WATER PROCESSING EQUIPMENT

"I wasn't born yesterday. I fixed that bell so it didn't bother me," said the janitor.

Foolproof boilers aren't for fools

► With Mechanical Packing, my 24-page manual in this issue, spanked and put to press last night, I suggested to Editor Lou Rowley that he and I celebrate by having a snack, with fitting refreshments, at Bedlam's Bent Propeller Bar. As always, old "even-keel" Lou was agreeable and before long we were plowing through the snow along the nearby water front.

Across the street two tugs were blasting the cold night air to shreds as they warped an Australian freighter alongside a pier. The giant SS *United States* came gliding silently up the Hudson, her decks lit up like a Christmas tree. And suddenly, there before us was the symbol of waterfront hospitality and good fellowship for all weary seamen from the world's four corners—the Bent Propeller Bar. This was Marmy's world, and I knew we'd find him around.

Lou and I stepped inside. Above the loud guffaws and noisy conversation we could hear our hero, that most extraordinary engineer Marmaduke Surfaceblow himself, moored at one end of the crowded bar while he thundered away. Bedlam edged through the crowd and shook hands with us, then showed us to the only vacant table. He motioned a white-aproned waiter to take care of us, while he casually took care of a noisy seaman by gently heaving him out the door.

"Solar generators—that's what I'm reading up on," we heard a husky gent standing next to Marmy exclaim as he siphoned foam from a mug of beer.

"Bilge water on solar generators," roared Marmy at the top of his foghorn voice, as he clenched his fist and banged down on the bar. "I'll tell you about the time three fools balled up the foolproof controls on a package-type boiler so badly that it shut down the plant."

That did it. The place became quiet as a derelict ship in a bone yard. Marmy turned his stern to the bar, characteristically listed his old gray bowler slightly to starboard, hooked his huge thumbs into the armpits of his checkered vest and blasted away.

"Back in 1946, I was a boiler insurance inspector down in Georgia. One night I got an SOS from a client near Cordele. He started blowing his stack about his small textile mill being shut down. Said his large package boiler had failed and he wanted me to get there on the double to supervise repairs and get the plant back into production.

"I looked up his file and found he had a 200-hp package type, Scotch dry-back boiler, with all the safety devices. She carried 145 psi and was only about seven months old.

"Driving down, I tried to figure out how that boiler could have failed. My records showed it had all the protection any boiler could have. That included a flame-failure device, protection against low water and overpressure. And for good measure she had not one but *two* low-water fuel cutouts.

"I've seen automatic kettles fail before, but they were all older jobs that had had time to be badly neglected. Then the safety devices just couldn't work. But this boiler was only seven months old. The more I thought about it, driving down there, the more impossible it sounded.

(Continued on page 202)

Forest of Facts on Nalco® RECIRCULATING WATER TREATMENT

NALCO Laboratories' continuous research program has gathered this forest of facts about protecting recirculating water systems. In the search for the most effective *and economical* formula, the metal rods shown have been rotated in all types of recirculating waters and treating chemicals. Results pointed the way to a group of Nalco Treatments which assure users against scale and corrosion in virtually any recirculating waters. For details on Nalco Treatment to fit your particular system, call your Nalco Representative, or write direct.

Test rod from water treated with the Nalco 82 Method shows protective film and freedom from any scaling or corrosive attack.

THE Nalco 82 METHOD MAY BE THE ANSWER FOR YOU

The Nalco 82 Method is particularly suitable for scale and corrosion control in recirculating water systems which fall within the characteristic limits given here. Check them to see if your system should have Nalco 82 Treatment:

- Equipment to be protected contains steel and/or brass.
- Hardness of makeup water is more than 50 ppm; and sulphates and chlorides, as sodium salts, are less than 150 ppm.
- Calcium hardness of makeup can be as much as 500 ppm.
- Silica content of makeup water up to 50 ppm.
- Total alkalinity of makeup more than 40 ppm.
- Recirculation rates between 100 and 100,000 g.p.m.
- Where non-toxic waste water is required.

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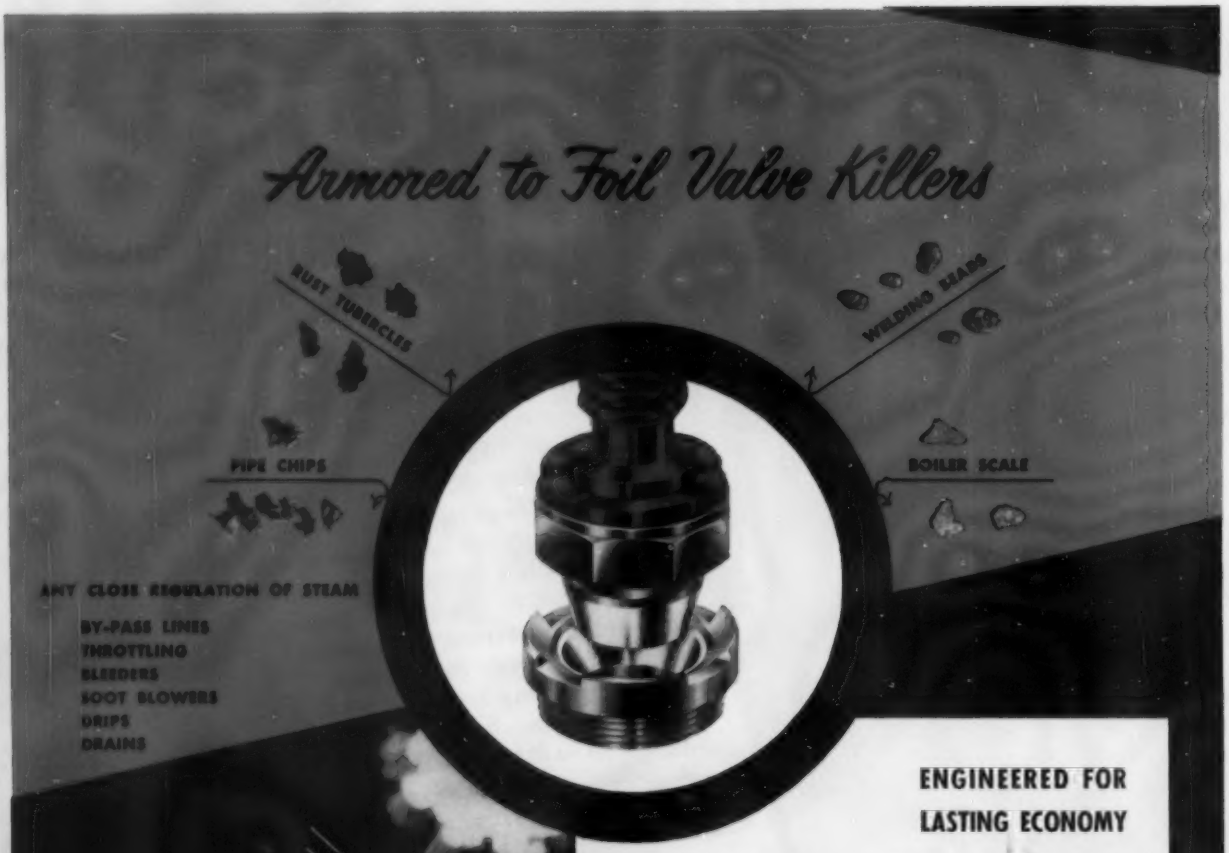

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Plug and seat ring are Jenkins JX500, a Stainless chromium alloy steel made to Jenkins high strength specifications, heat-treated to 500 Brinell hardness. Seating surfaces are super-hard and mirror-smooth, offer highest resistance to galling, cutting, abrasion, and erosion . . . and "wire drawing" effects of close regulation of steam.

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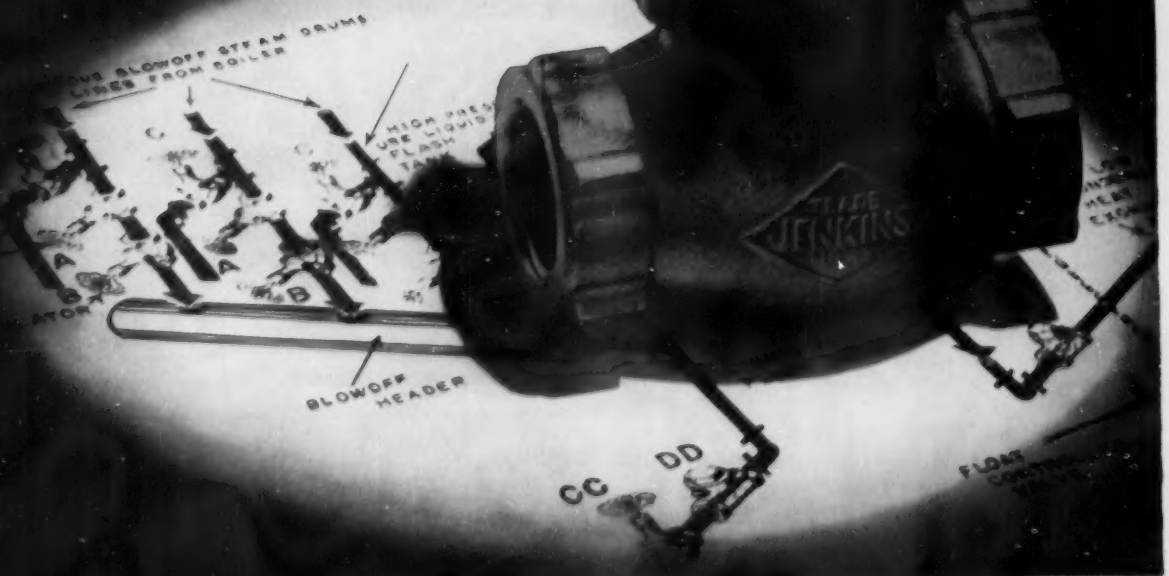


300 lb. 200 lb. 150 lb. Globe and Angle

Reader service section

Start with these quick samples . . .

Complacent Americans . . .

shrug shoulders at reports of Soviet progress. But in one key sector, the training of engineers, our Russian friends are way out in front, and have been for three years. Last year, as an eye-opening story in Reports from the Field tells, they led U.S. by 34,000 grads! While you're reading this department, check the late news on the program for the upcoming American Power Conference, slated for Chicago, March 30-April 1 . . . . . p 160

Using the squeal . . .

makes meat-packing efficient. And utilizing exhaust gas opens up new possibilities for gas turbines. Abstract, schematic drawings, directions for getting your complete report, in Technical Briefs, starting on . . . . . p 162

One cradle serves eleven . . .

process pumps in one of a new series introduced by Dean Bros. Featuring interchangeability, variations of just three parts determine pump size and capacity. Plant Equipment News gives you the low-down on this and other problem-solving product developments, begins on . . . . . p 166

About to blow your top . . .

as pressure nudges 2500 psi and temperature rises to 1050 F? Order item No. 32 from this month's Free Literature columns. For convenience and speed in obtaining any bulletin, use handy postcards . . . . . p 175

Ho hum, what to do . . .

with 1930 hours of leisure time each year? Screwy? George Edwards is ready to prove you have that much . . . recommends using it . . . . . p 178

Names make news . . .

E J Schwannhausser is now president of Worthington Corp . . . O T Buckley awarded AIEE Edison Medal. To keep in touch with personalities in the news, check easy-reading Appointments columns . . . . . p 240

1000 gallons for 30¢ . . .

might be the price for extracting "Fresh Water from the Ocean." For more info, see book of that title by C B Ellis and staff members of Nuclear Development Associates, Inc, reviewed in Bookshelf . . . . . p 248

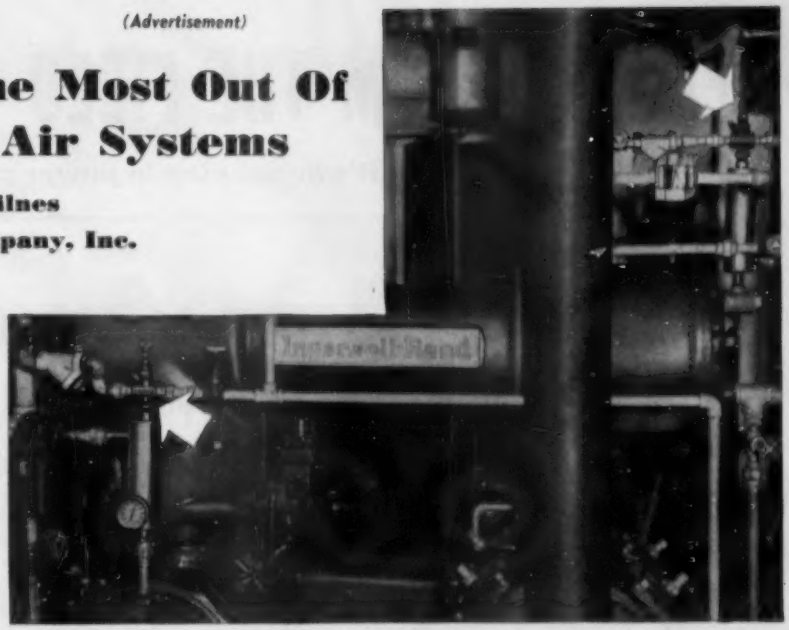
For other timely ideas, see following service pages ▶

(Advertisement)

How To Get The Most Out Of Compressed Air Systems

A. Milnes

Sarco Company, Inc.



The replacement of hand controls by Sarco automatic cooling controls on this 2-stage Ingersoll-Rand compressor resulted in better lubrication, less condensate in air, and a considerable saving in cooling water.

THE practical place to measure the capacity of your compressed air system is where it counts the most—at your compressed air tools. From the time air is first drawn into the cylinder, many things can happen which will effectively reduce air pressure and limit compressor capacity. Following is a concise explanation of the major causes of reduced compressor capacity and the steps which can be taken to remedy them.

PROPER AIR INTAKE

Your compressor system can be fouled up before a pound of air has been compressed if the air intake has been improperly located. The air intake should be located where the atmosphere is clean, cool, free from corrosive chemical fumes, and dry to minimize condensation in the system.

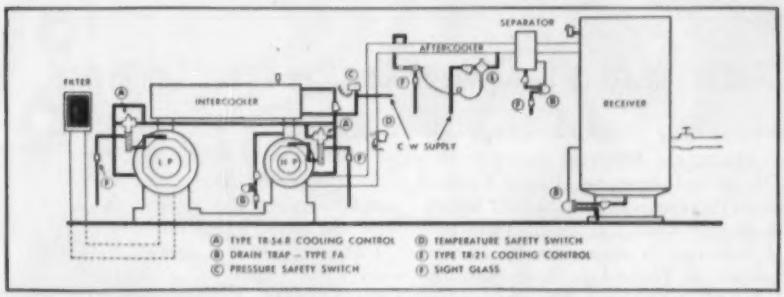
INTAKE PIPE DESIGN

A compressor can only operate at rated capacity if its air supply is unimpeded. Twisting, undersized pipes and dirty filters can effectively reduce air pressure at the compressor inlet. For example, a pressure loss of 2 psi due to friction in the intake pipe and filter will reduce the output of a 125 psi compressor by 7.5%. Check intake pipes and make sure they are short, of adequate size, and free of sharp bends.

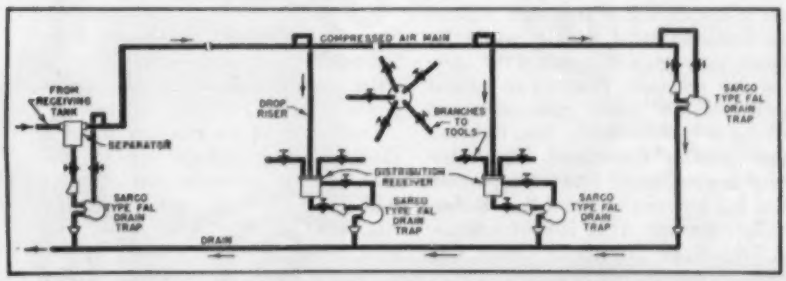
AUTOMATIC COOLING CONTROL

One of the major causes of inefficient compressed air operation is unbalanced cooling. For example, overcooling wastes water, causes deterioration of compressor lubricant by condensation in cylinder head. On the other hand, undercooling reduces compressor capacity, may result in serious damage to cylinders, pistons, valves and seats.

To offset this, many compressor manufacturers such as Schramm, Ingersoll-Rand, and others install Sarco automatic cooling controls at the factory. These controls are self-modulating, insure optimum cooling effect with minimum water consumption regardless of load variation, changes in pressure and temperature of water supply.



Sarco cooling controls are installed to regulate the water supply to cylinder jackets so that jacket discharge temperature is between 100-115° F.



Drain traps at critical points in the distribution system effectively remove condensate—protect compressor equipment, tools, and work.

CONDENSATE REMOVAL

If condensation is not kept to a minimum serious damage can result to tools, paint surfaces, molds, etc. Other results of excessive condensation in the system are water hammer and freezing of mains, receivers and tool exhausts.

To prevent this, well-designed compressed air systems usually have Sarco drain traps installed at the aftercooler, on separators, at receivers, and on low points in the lines to remove water as quickly as it collects.

FREE TECHNICAL ADVICE

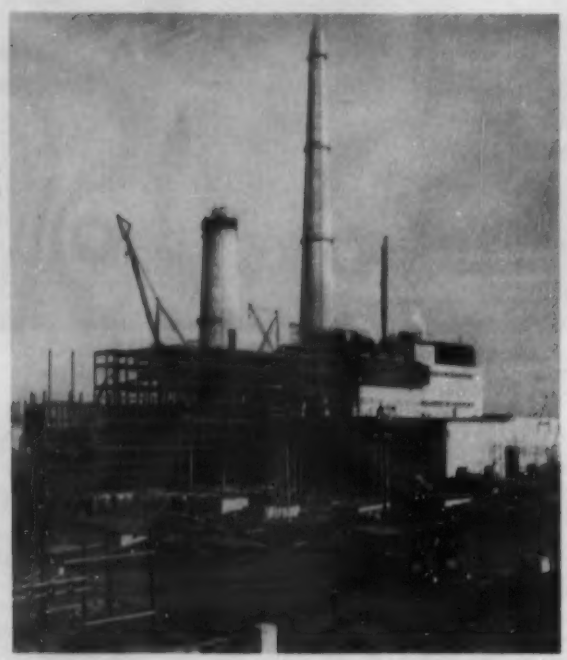
Sarco engineers have prepared a technical bulletin designed to pass on to compressed air users practical advice on how to improve air compressor operation. It also contains simple hook-ups of Sarco cooling controls and drain traps.

This bulletin may be obtained without obligation by writing the Sarco Company, Inc., Empire State Building, N.Y. 1, N.Y. Also represented in principal cities.

REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 234



KYGER CREEK will have generating capacity of 1,000,000 kw

Private industry's largest electric power plants go into operation

► THE FIRST 200,000-KW turbine-generating unit at each of two Ohio Valley Electric Corp plants has been placed in service. Located at Clifty Creek, Madison, Ind. and Kyger Creek, Cheshire, Ohio the units will be the largest electric power plants ever built by private industry. Their power is being delivered to the Atomic Energy Commission's new uranium diffusion plant near Portsmouth, Ohio.

Ground was broken at both Clifty Creek and Kyger Creek in December 1952. Upon completion, Clifty Creek will have six 200,000-kw units, or a total capability of 1,200,000 kw—greater than any steam power plant operating today. It will represent an investment of about $175 million. Kyger Creek will have five units of the same size totaling 1,000,000 kw. It will cost about $145 million upon completion. All units will operate at a steam pressure of 2000 psi and steam temperature of 1050 F. They are expected to burn a total of about 7½-million tons of coal a year.

The tremendous bulk of power generated by the two plants will be fed over double-circuit 330,000-v transmission lines—highest voltage lines in the nation—to the AEC plant. At the latter, electric energy will be used in large-scale multi-stage process, separating isotope U-235 from natural uranium.

Soviet Union leads U.S. in race for engineering graduates

► THE SOVIET UNION is graduating more engineers than the U.S. and has been since 1952. These facts were brought forth in a recent press conference sponsored by Columbia School of Engineering and the Engineering Manpower Commission of Engineers Joint Council.

Russia has made a steady rise in engineering graduates since 1945, while in the U.S. total graduates rose for 5 yrs and declined during the next 5 yrs. The middle of 1952 was the critical time. Although industries and government are calling for more technical men, supply has fallen from a peak of 50,000 graduates in 1950 to 20,000 this year. Russia has completely reversed the situation, graduating 28,000 engineers in 1950 and 54,000 last year.

According to statistics of the Office

(*Continued on page* 228)

Special sessions to highlight American Power Conference

► USING NEW SOURCES of energy will be among the principal topics at the 17th annual American Power Conference. This conference, to be held March 30 through April 1 at the Sherman Hotel, Chicago, is sponsored by Illinois Institute of Technology in cooperation with 14 universities and 9 engineering societies.

Special sessions are planned on the use of nuclear and solar energy. A panel on development of atomic energy for power purposes will highlight the opening day program. Progress in nuclear technology for power generation, and efforts to capture energy from the sun's rays will also be discussed. The conference is open to all interested persons. For full information write R A Budenholzer, director, APC, Illinois Institute of Technology, Technology Center, Chicago 16, Illinois.

A partial listing of topics to be presented during the 3-day event follows:

Wednesday, March 30, 1955

INTRODUCTORY ADDRESSES: Where we stand today in the electric industry; Research in the utility industry.

CENTRAL STATION STEAM GENERATORS: The monotube or once-through boiler for standard or supercritical pressures; The operation of large central station steam generators.

WATER RESOURCES: St. Lawrence seaway; Utilization of saline waters; Rainfall cycles and water supply; Use of water for irrigation, navigation and power.

INDUSTRIAL STEAM AND POWER: When should industry build a power plant; Let's take the guesswork out of industrial power costs; Fast starting of 150,000 pound per hour industrial boilers; How to reduce spreader stoker fly ash.

ELECTRONIC APPLICATIONS: Closed-

(*Continued on page* 228)

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custom made to your mechanical and metallurgical specifications

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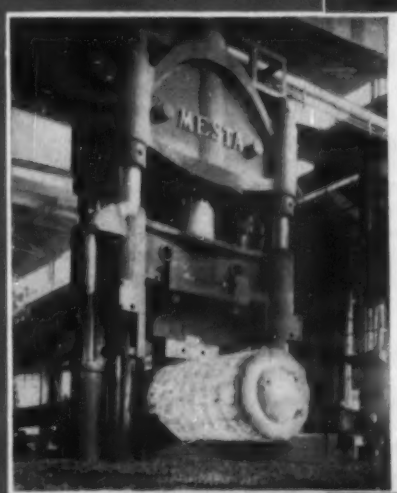

● Forging High Pressure—High Temperature Pipe on a MESTA 6000 Ton Hydraulic Press in one of the MESTA Forging Shops.

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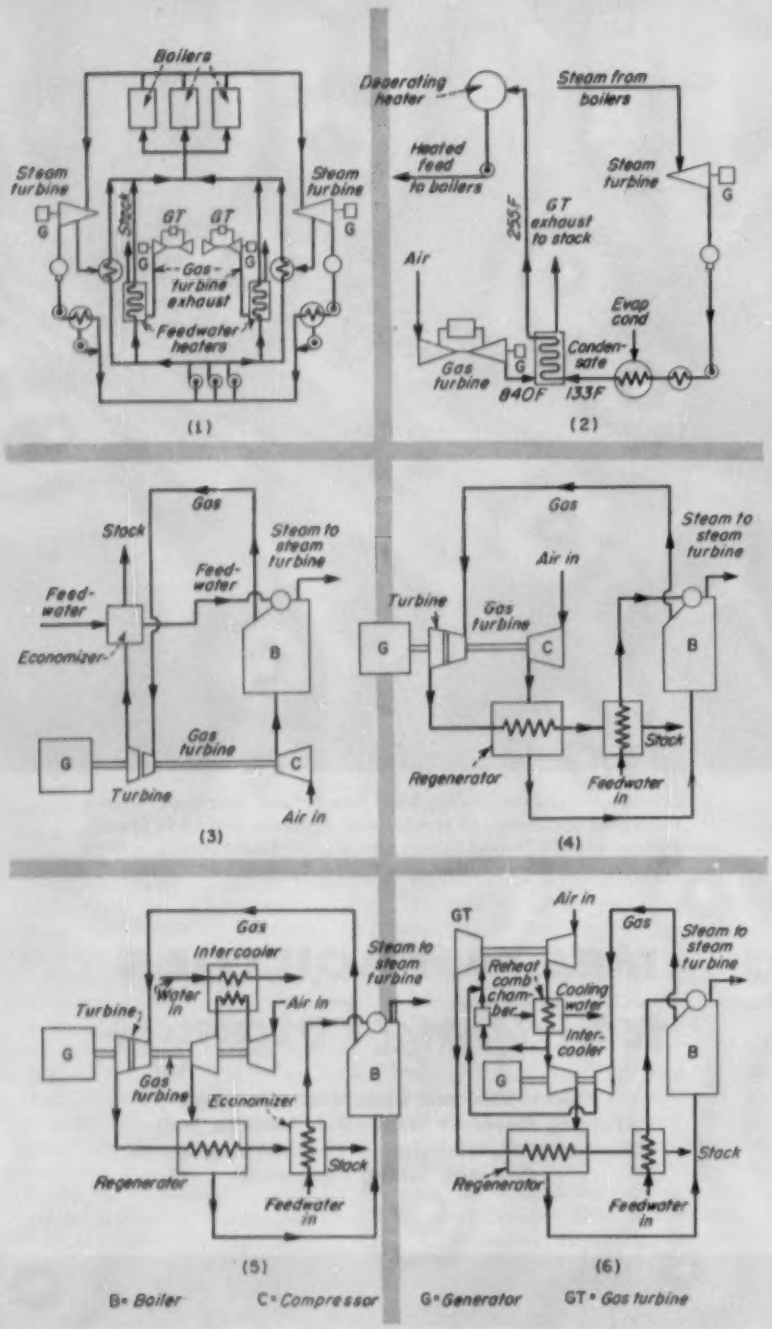
TECHNICAL BRIEFS

Latest engineering developments for busy power men

15 Digests for you on:
GAS TURBINES
NUCLEAR POWER
FEEDWATER
STEAM POWER

Six steam plants using gas-turbine exhaust heat



Gas-turbine exhaust-heat recovery. *By A A Hafer, gas turbine dept and W B Wilson, industrial engineering section, General Electric Company.*

Efforts in improving gas-turbine cycle efficiency have been primarily limited to the cycle itself. But it is now realized the gas turbine produces more than just shaft power.

It can also produce compressed air and hot exhaust gas. The latter is usable in various exhaust-heat applications. Since exhaust gas retains the major portion of its oxygen, it can be used as highly preheated air for other combustion processes.

This paper discusses exhaust-heat and combustion applications. Thermodynamic aspects are reviewed. Subjects covered include: combined steam-gas turbine plants, present applications of gas turbines with exhaust-heat recovery, regenerators, feedwater heating, exhaust heat-recovery boilers, exhaust-gas drying of manufactured products, combined steam-gas turbine supercharged boiler plant, gas-turbine stack ejector for compartment ventilation and the exhaust-fired gas-turbine cycle.

Fig. 1 shows a typical feedwater-heating application in a station having two gas turbines and two condensing steam turbines. The plant in Fig. 2 has three 6000-kw steam turbines. It reports a 15.15% gain in thermal efficiency by addition of a single 5000-kw gas turbine with exhaust-heat recovery for feedwater heating.

Fig. 3-6 show four different forms of combined steam-gas turbine supercharged boiler plants. Fig. 3 is simplest, has a simple-cycle gas turbine. Fig. 4 shows addition of a regenerator to the plant, Fig. 5 a regenerator and intercooler, and Fig. 6 a regenerator, intercooler and reheater. In general, the more complex the gas-turbine cycle, the higher the over-all plant thermal efficiency. *ASME paper no. 54-A-194.*

Free-piston gas-turbine prime movers—a review of basic principles. *By A J Ehrat, Baldwin-Lima-Hamilton Corp.*

Active American evaluation of free-piston gas-turbine prime movers has

Your J-M Packings Distributor can tell you why this quality sheet packing has maintained such an excellent reputation for over 35 years

Where it's used: Every industrial plant can use J-M Service Sheet Packing to advantage. It's the favorite packing of thousands of plant engineers and maintenance men. Both versatile and dependable, Service Sheet makes a tight, long-lasting seal against superheated steam, air, gas, water, hot oil and ammonia, as well as many acids and chemicals.

What its advantages are: J-M Service Sheet is a quality packing, made of selected long-fibre asbestos bonded with heat-resisting compounds. It is graphited on one side to permit breaking a joint without destroying the gasket. The ungraphited side is ruled into one-inch squares to speed cutting and reduce waste. And . . . you can order it in large economical quantities because J-M Service Sheet will not dry out in stock!

How it is furnished: Service Sheet is supplied in sheets 54" x 63", 36" x 126", 36" x 63", and 54" x 126" sheets in thicknesses of 1/64" to ¼" and 108" x 126" sheets in thicknesses of 1/32" to ¼". It is also furnished as cut gaskets in standard and special shapes. See the J-M catalog for further details.

Your J-M Packings Distributor carries complete stocks of J-M Service Sheet and other quality Johns-Manville Packings. He can help you choose the right packing for your application. Write him for complete information and copy of folder PK-19A, "Thousands of Plants Rate It Tops." Or address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

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More TECHNICAL BRIEFS

Begins on page 162

been continuing since before the end of World War II, although on a very limited scale in proportion to that of gas-turbine prime movers as a whole. During the early years, the U.S. Navy and Baldwin-Lima-Hamilton Corp carried on the fundamental work. But today at least two other firms are engaged in separate evaluations. Many other signs indicate spreading interest.

This paper reviews some fundamental principles and advantages of free-piston gas-turbine prime movers. It describes the cycle, arrangement of cylinders, sequence of events during operation, principles governing piston motion, and requirements for combined operation of the free-piston gasifier and turbine.

Extent to which free-piston gas-turbine machinery will be applied cannot be predicted with accuracy. However, it is the author's conviction that such equipment can take its place beside other successful prime movers because there are many inherent advantages to its use. *ASME paper no. 54-A-67.*

Modified residual fuel for gas turbines. *By Bruce Buckland and Donald Sanders, gas turbine dept, General Electric Co.*

Sodium in gas-turbine fuel causes rapid deposit formation as well as corrosion. Besides naturally contained sodium, sea-water contamination during transportation introduces additional amounts.

To obtain the benefits of low-sodium fuel, 90% or more of sodium is washed out of it. Results of desalting show that calcium can also be reduced.

Turbine tests of 50 to 1500 hr duration using these desalted fuels show that deposit can be almost eliminated by keeping both sodium and calcium below 10 ppm. Steady-stage decrease in turbine efficiency, resulting from burning these low-sodium low-calcium fuels, is about 2% and reduction in regenerator effectiveness about 5 points.

Treating vanadium-containing fuels with calcium or magnesium shows that below 1650 F, magnesium is a better inhibitor than calcium, and since magnesium does not cause deposit, it is used. Lead in the fuel, in sufficient quantities, somewhat spoils the inhibition of vanadium by magnesium. *ASME paper no. 54-A-246.*

Operating experience on General Electric gas turbines. *By W B Moyer, General Electric Company.*

Today's gas turbine is an accepted prime mover, having reliable and efficient operation with low-cost maintenance when fired on natural-gas fuel. It is accumulating greatly improved operating experience using treated residual oil fuel, that promises to approach natural-gas operating experience.

Major improvements required to make residual-fuel turbine operation equal that of natural gas lie in providing noncorrosive fuel and in further advances in combustion system and accessories. Much progress has been made on these points and the future looks very encouraging.

Major operating and maintenance problems of combustion inspections and turbine cleaning have been reduced to practical procedures. Further progress is anticipated in the near future on fuel-nozzle and first-stage nozzle maintenance. The over-all maintenance problem will be an improving one as more experience is obtained. There have been no basic maintenance items encountered to date that, with proper concentration of effort, have not been solved satisfactorily. Over-all availability of gas-turbine plants today averages close to 90%, and is steadily improving. *ASME paper no. 54-A-160.*

Directions for ordering papers on p 260

Nuclear power

A reactor emergency—with improvements adopted as a result. *By G W Hatfield, Atomic Energy of Canada, Ltd.*

On Dec 12, 1952, a mechanical failure occurred in the shut-off rod system of Canada's NRX experimental nuclear reactor, leading to a power surge. Subsequent failures of elements in the system lead to the leaching of fission products into water that flowed into the building's basement.

At the time of the accident cooling water flooded the basement at the rate of 300 gpm and water at one stage rose to a level halfway up the instrument-panel board.

Active water collecting in the basement was pumped to large storage tanks outside the main building. Since they were rapidly filling to capacity, a decision was made 5 days after the accident to pump this water to a disposal area. About one million gallons of active water containing 10,000 curies of long-lived fission products were pumped to disposal.

During dismantling of the reactor, many special tools had to be designed and fabricated. It was reconstructed, many of the original parts being used after decontamination. Problems faced during the 8 months while the reactor was being dismantled are extremely interesting and required much ingenuity for their solution. A number of safety measures, based on this emergency, are given. *ASME paper no. 54-A-224.*

Basic safety procedures in reactor operation. *By R L Doan, atomic energy div, Phillips Petroleum Company.*

Successful operation of a nuclear-reactor plant depends on close adherence to all the usual rules of safety plus a number that are unusual for installations not concerned with nuclear reactions and radioactivity. It is an interesting fact that, while these unusual aspects of nuclear-reactor operations are potentially far more hazardous than ordinary plant operations, almost all injuries occurring around such plants are due to nonnuclear causes.

Most logical explanation for this appears to be that it was recognized at the start of large-scale atomic-energy activities in 1942 that it would be necessary to do some vigorous research on biological effects of nuclear radiations. Also, it would be necessary to put into action some strictly enforced working regulations if serious radiation damage to personnel was to be avoided.

Thus was born, or at least pushed into adolescence, the field of activity somewhat prematurely labelled Health Physics. The very low injury rate due to nuclear radiations thus far in this country is a tribute to the vigor and effectiveness with which the personnel radiation protection program has been pushed by the Atomic Energy Commission. *ASME paper no. 54-A-71.*

Disposal of radioactive wastes. *By Abel Wolman, Consultant, and Arthur E Gorman, Atomic Energy Commission.*

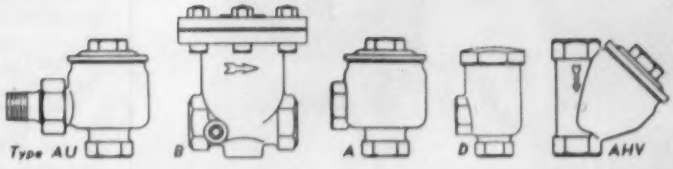
Radioactive wastes present many problems, including (1) design of facilities to ventilate and remove radioactive dusts, fumes and gases from working areas (2) research in disposal of combustible radioactive wastes by incineration and related processes (3) development of remote control equipment for handling and transporting highly radioactive materials (4) improving heat-exchange methods where extraordinary temperature conditions exist.

Control of waste is currently adequate, but expensive. As the industry expands, especially in the power field, less ex-

(*Continued on page* 252)

NICHOLSON Steam Traps'

1. *Initial Cost*
2. *Upkeep Expense*
3. *Warm-Up Time*
4. *Production Time*



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¼" to 2" sizes for pressures from vacuum to 300 lbs. Bronze, monel or stainless steel bellows. Bronze, semi-steel or cast steel bodies.

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PLANT EQUIPMENT NEWS

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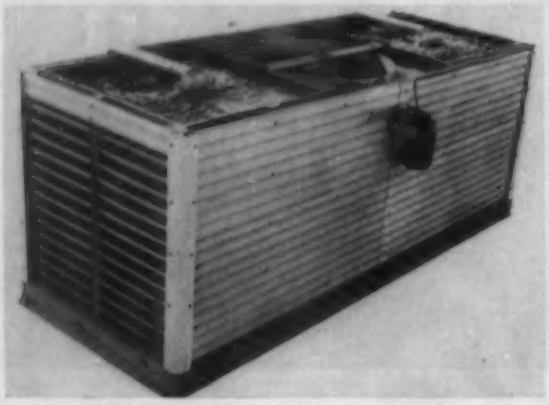
Improved cooling tower designs



Mechanical draft units for air conditioning use

301 • Mechanical draft cooling towers handle air conditioning loads of 75 tons and up. Design feature is low over-all height, making units suitable for both lower-lined suburban buildings and for metropolitan buildings where units must be roof-mounted.

Although built to accommodate conventional external water supply piping, concealed internal piping is available as an optional feature. Fittings are brought to outside of tower for ease of lubrication. *Lo-Line* tower will also handle a variety of industrial cooling duties. Full details in bulletin 5.1.902.

J F Pritchard & Co, 4625 Roanoke Pkwy, Kansas City, Mo.

Cooling tower designed to control recirculation

302 • *Wind-trol* tower is said to offer improved operating efficiency by controlling recirculation. It can be located without respect to wind direction. Rearrangement of standard component parts, according to company, nullifies effect of recirculation caused by tower structure upon itself. Uncontaminated air passes beneath structure and supplies fans on both sides of tower with excess air discharging from tower's leeward side. Recirculation is prevented since exhaust vapors must move against this discharging wind stream.

Tower is claimed to be free from vibration. It is mounted on an open substructure and supported by concrete piles. Forced draft fans are not connected to tower but individually mounted outside packing area. Construction and operational details available on request to the manufacturer.

Santa Fe Tank and Tower Company, Inc, 5401 South Boyle Ave, Los Angeles 58, California

Dust collecting unit has secondary circuit

303 • Unit differs from conventional systems by having a secondary circuit that keeps discharge from the small cyclones under constant negative pressure. This prevents recycling of dust in the primary system. Manufacturer claims that collection efficiency for dust particles in the 0 to 15 micron range far exceeds that of similar systems lacking the secondary circuit. System is adaptable to high- and low-temperature gases, containing small and large abrasive or non-abrasive particles.

Aerodyne Corp, 1520 Lakeside Ave, Cleveland, Ohio

Blower units have backward curved blades

304 • Non-overloading centrifugal blowers with backward curved blades have arc-welded steel frames and heavy gauge steel housings. Included in the line are belt-drive utility blowers, 12¼ to 36½ in; direct-drive utility blowers, 12¼ to 33 in; Arrangement 2 blowers, 12¼ to 36½ in; Arrangement 3 blowers in single width, single inlet construction, 24½ to 49 in; and Arrangement 3 blowers in double width, double inlet construction, 12¼ to 49 in. Ball bearing construction is standard on all models. Motors can be supplied for any current characteristics and special operational requirements. All wheels are dynamically balanced.

Hartzell Propeller Fan Company, Piqua, Ohio

Water-cooled lens system for industrial TV

305 • Water-cooled lens system permits direct viewing of furnaces, boilers and other high-temperature operations up to 3000 F. Using a high-efficiency closed-circuit water circulating system, it reduces infra-red radiation and lens temperatures at the camera below 120 F. System is adaptable to multiple camera installations. Further details in bulletin E.52, obtainable on request to manufacturer.

Radio Corp of America, Engineering Products Div, Building 15-1, Camden 2, New Jersey

Thermometer permits readings at the process

306 • Thermometer is used for field readings of process changes. Dial graduations are carried on a raised ring, set close to glass, with index-type hand at the same level. Parallax error is practically eliminated, manufacturer states.

Case, threaded bezel and stem are constructed of stainless steel. Only 3-in. in diameter, unit has bi-metal coils welded to stem plug. Ranges are available from –80 to + 1000 F, with dials graduated in either Fahrenheit or Centigrade. Full details on request to manufacturer.

Manning, Maxwell & Moore, Inc, Stratford, Conn.

Low friction packing for hot corrosives

307 • *Super-Lon* packing is said to withstand such chemicals as fuming acid, concentrated sulphuric, oleum, or concentrated sodium hydroxide at temperatures to 550 F. *Super-Lon* is a braided Teflon fiber, claimed to have thirty times greater tensile strength than resinous, molded, coated or impregnated packings. It will not seize high speed shafts. Further information obtainable on request to manufacturer.

A W Chesterton Co, Everett 49, Massachusetts

To obtain additional information on these items, use the post cards on page 175. Identify your request with the item number.

CRANE VALVES have longest life in this sulphur pit

THE CASE HISTORY—Leakage in steam lines to sulphur pit heating coils was hindering operations at International Minerals & Chemical Corp. plant at Lockland, Ohio. The condition prevented servicing of traps, strainers and the heating coils.

Valves that leaked beyond repair after as little as 6 months' service were the source of the trouble. Their seating as well as packing failed to stand up.

In January, 1953, after trying other types, Crane 14½P Plug Type Disc Globe Valves were installed. Today, they're still giving excellent service at low cost. Recently, the steam piping was completely replaced—the Crane valves were repacked and put back in the lines. That's all the maintenance they needed after 18 months in this severe service.

Crane 150-Pound No. 14½P Plug Type Disc Brass Valves

Long-wearing, hard seating surfaces in a rugged, well-proportioned, Crane-designed body make these valves exceptionally suited for steam and other severe services. Consult your Crane Catalog or your Crane Representative.

CRANE CO.

General Offices: 836 S. Michigan Ave., Chicago 5, Illinois
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VALVES • FITTINGS • PIPE • PLUMBING • HEATING

CRANE'S FIRST CENTURY . . . 1855-1955

More EQUIPMENT NEWS

Begins on page 166

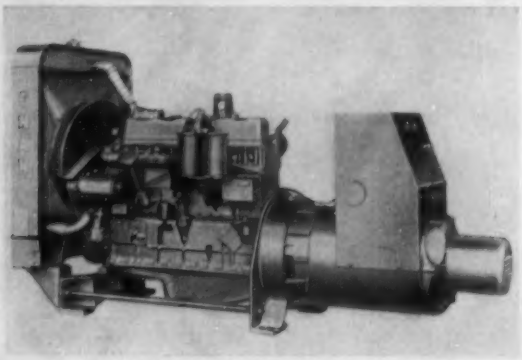
Totally-enclosed motor meets NEMA standards

319 • Completely enclosed unit conforms to dimensional standards recently adopted by NEMA. It is claimed to be more compactly designed than previous types, having the same horsepower in less space. According to manufacturer, greater protection is provided by improved types of enclosure, precision register fits, closer tolerances in machining, and numerous structural refinements. No general disassembly is required to gain access to the bearings.

Designated *Type J*, unit is engineered for operation where fumes, dusts and moisture are prevalent. Externally exposed surfaces are of cast iron for corrosion resistance. Frame is a solid cast structure, heavily ribbed around entire unit. Stator core is pre-wound and windings are asbestos protected.

The motor is being produced in ratings from 1 to 10 hp and may be had in the fanless type for lower ratings. Further information in bulletin 1879, obtainable on request.

U. S. Electrical Motors Inc, Box 2058, Los Angeles, Calif.



75-kw emergency electric generating unit

320 • Emergency generating plant of 75-kw capacity is designed to meet increased electrical requirements of food processing plants, chemical plants, public utilities, hospitals, etc, where interruption of power would result in costly losses.

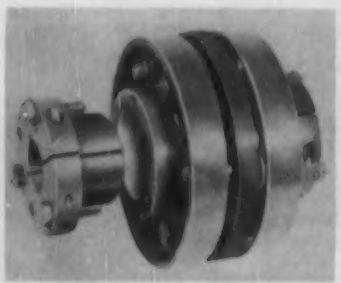
Unit's generator is said to be specifically designed to provide excellent electric motor starting. This makes the *Model 75HR* ideal for standby installation in buildings where many electric motors provide essential power. Generator is of ac revolving field type and is externally voltage regulated. Units are designed to permit parallel operation, and equipment for paralleling is available.

The gasoline-engine-driven units will produce either 75 kw of 60-cycle, ac, at 1800 rpm engine speed; or 60 kw of 50-cycle, ac, at 1500 rpm engine speed.

In addition to standby service the generating plant is suitable for jobs such as construction lighting and power.

D W Onan & Sons, Inc, Minneapolis 14, Minnesota

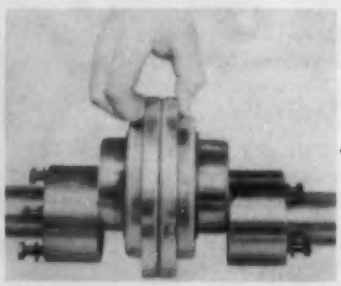
Three coupling units of timely interest in mechanical drive circles



Flexible coupling units

322 • These couplings, through use of split-taper bushings, will accommodate the widest range of shaft sizes. Units are available in 8 sizes based on hp ratings to 75 hp at 100 rpm. Split-taper bushing is of one-piece construction, with socket-head cross bolt across the compression slot. Two bushings are used to mount coupling, one to the driver- and one to the driven-shaft.

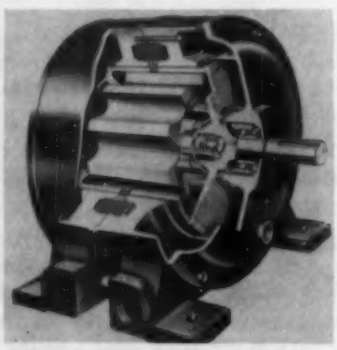
Climax Metals Products Co, 863 E 140th St, Cleveland 10, Ohio



Spacer-type shaft couplings

323 • *Type F Steelflex* coupling is designed for use between motors and pumps or for other applications where a gap to 12 in. cannot be avoided. It may be installed or disconnected without disturbing either driver- or driven-unit. Grid-groove design provides positive protection against damaging effect of shock loads, impact loads and vibration. Further details on request.

Falk Corp, Dept 361, 3001 W Canal St, Milwaukee 8, Wis.

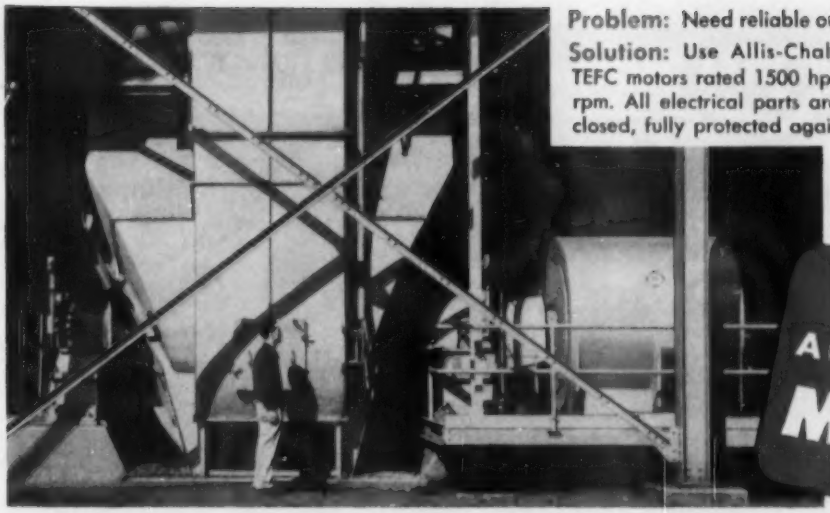


Adjustable speed drive

321 • *Dynaspede* coupling is a stationary field, liquid-cooled eddy-current adjustable speed power transmission device. Driven by constant or variable speed power source, unit delivers torque or speed to suit specific processing requirements. All rotating electrical components—slip rings, brushes, commutators and coils—are eliminated. Request bulletin SF-1 for full details.

Dynamatic div, Eaton Manufacturing Co, Kenosha, Wisconsin

For more data on these items, use post cards, p 175. Identify your request with item number.



Problem: Need reliable outdoor operation.

Solution: Use Allis-Chalmers tube-type TEFC motors rated 1500 hp, 4000 volts, 880 rpm. All electrical parts are completely enclosed, fully protected against weather.

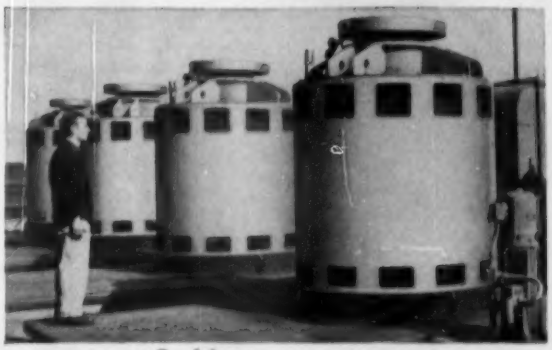
ALLIS-CHALMERS
Auxiliary-Drive
MOTORS

3 Problems — 3 Solutions

Eastern Utility Gets Exactly the Right Motor for Each Job from Allis-Chalmers

Public Service Electric and Gas Company chose Allis-Chalmers motors for many of the major auxiliaries in their Kearny (N. J.) Generating Plant. The reasons: reliability and economy.

Allis-Chalmers builds a type and size for every auxiliary drive in the power plant. Whether your problem is space, fly ash or an outdoor location, there's a motor in the Allis-Chalmers line to provide the continuity of service you need. Let an Allis-Chalmers representative help you select the motors for your job. A-4582

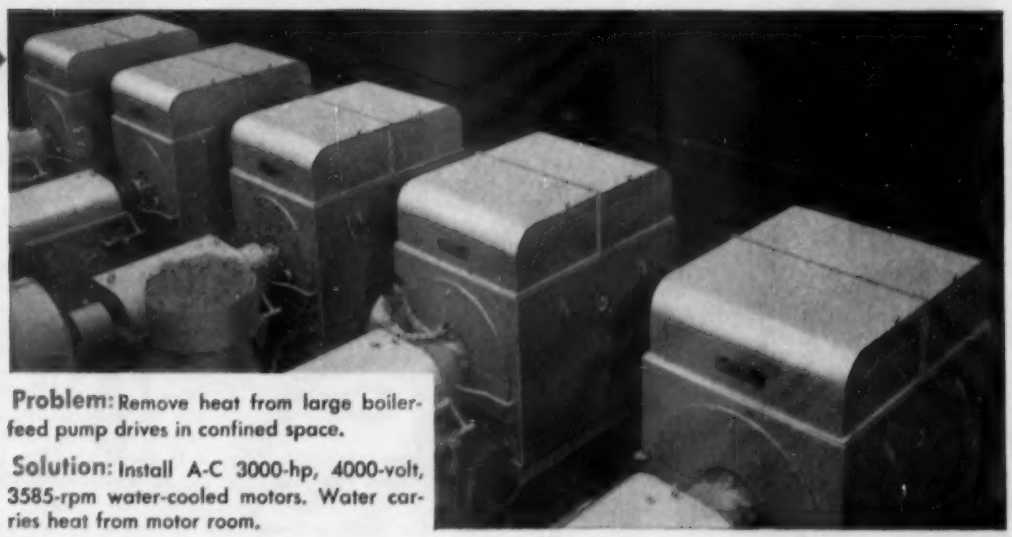


Problem: Keep building costs down.

Solution: Put pump drives outdoors, using Allis-Chalmers tube-type TEFC motors rated 350 hp, 440 volts, 400 rpm.

ALLIS-CHALMERS

Milwaukee 1, Wisconsin



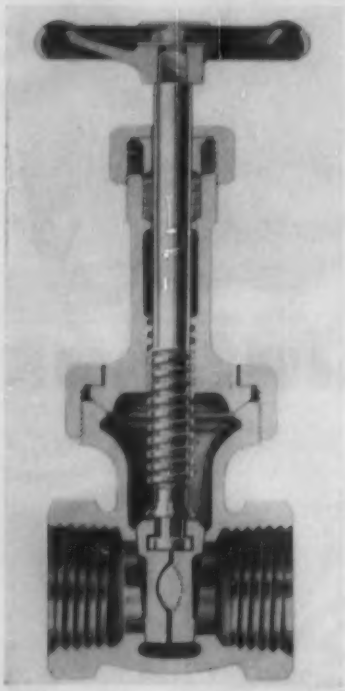
Problem: Remove heat from large boiler-feed pump drives in confined space.

Solution: Install A-C 3000-hp, 4000-volt, 3585-rpm water-cooled motors. Water carries heat from motor room.

EQUIPMENT NEWS

Begins on page 166

Check these 5 items for possible answers to your valve problems



Bronze gate valves designed for pressures of 150 pounds

308 • Bronze gate valves are constructed for general full-flow service on steam, water, oil or gas. Sizes range from ¼ to 3 in. Units, available in either split or solid wedge, are equipped with a rising stem that gives visual indication of wedge position. Operating threads are out of direct contact with fluid. Stems are made of an aluminum-silicon-bronze alloy, said to have high corrosion resistance.

Each valve is given hydrostatic shell and seat tests, according to manufacturer, and is designed for working pressure of 150 psi. End threads conform to American Standard for Pipe Threads. They may be used with pipe threaded to American Petroleum Institute Standard for Threads in Valves. All handwheels are of malleable iron.

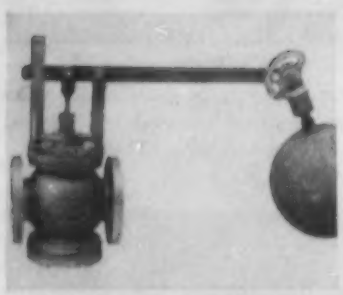
Split wedge design is recommended for use where body seats might be slightly distorted due to pipe line strains. Solid wedge is designed for general use, and is particularly adapted for steam service. There are no loose parts to vibrate or wear as with two-piece discs, manufacturer states. Further details as to construction and application available on request.

R-P&C Valve division, American Chain & Cable Co, Reading, Pa.

Solenoid-controlled valve

309 • Full-flow units may be used to close any fuel or process line. In operation, release of locking device by the control permits valve disc to drop into stream. Flowing stream forces valve disc into place, or, if there is no flow at time of actuation, valve disc is positioned by its own weight. Valve must be reset manually after actuation. Standard units are rated at 300 psi. Request form 102 for further details.

McRae Corp, 621 S Spring St, Los Angeles 14, California

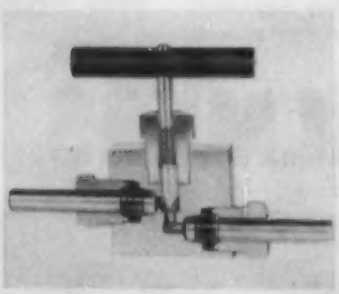


Direct-acting float valve

310 • Float-type valve is designed to control levels of liquids in many industrial operations. They may be used in open storage tanks, process tanks, spray ponds, cooling tower basins and similar liquid reservoirs.

Units are constructed mainly of bronze and steel, however other metals for special applications are available. They can be ordered in 11 sizes from ¼ to 4 in. Larger sizes are supplied with a semi-balanced, double-seated valve. They may be used for slurries or liquids containing suspended solids.

Fulton Sylphon division, Robertshaw-Fulton Controls Company, Box 400, Knoxville, Tennessee



Valves for use on tubing

311 • *TubeLine* valves can be cut into lines much faster and more easily than conventional screw-end valves, manufacturer states. Pipe-threading is eliminated. Tubing is cut to desired length and burrs are filed off. An adapter nut and sleeve are slipped onto tubing and connected to the valve, forming a gas-tight seal.

Valve body is made of *Type 304* stainless steel and valve stem is of heat treated *Type 410* stainless steel with a rolled thread. Units will hold pressures to 4000 psi. Complete information on request to manufacturer.

Autoclave Engineers, Inc, 891 E 19th St, Erie, Pa.

Direct lift solenoid valve

312 • Designed for general service, units are made in ⅛ and ¼-in. pipe sizes, with ports from 1/16 to ¼ in. Maximum pressures obtainable are 1000 psi for air and gas; 600 psi for water; 500 psi for oil, and 200 psi for steam.

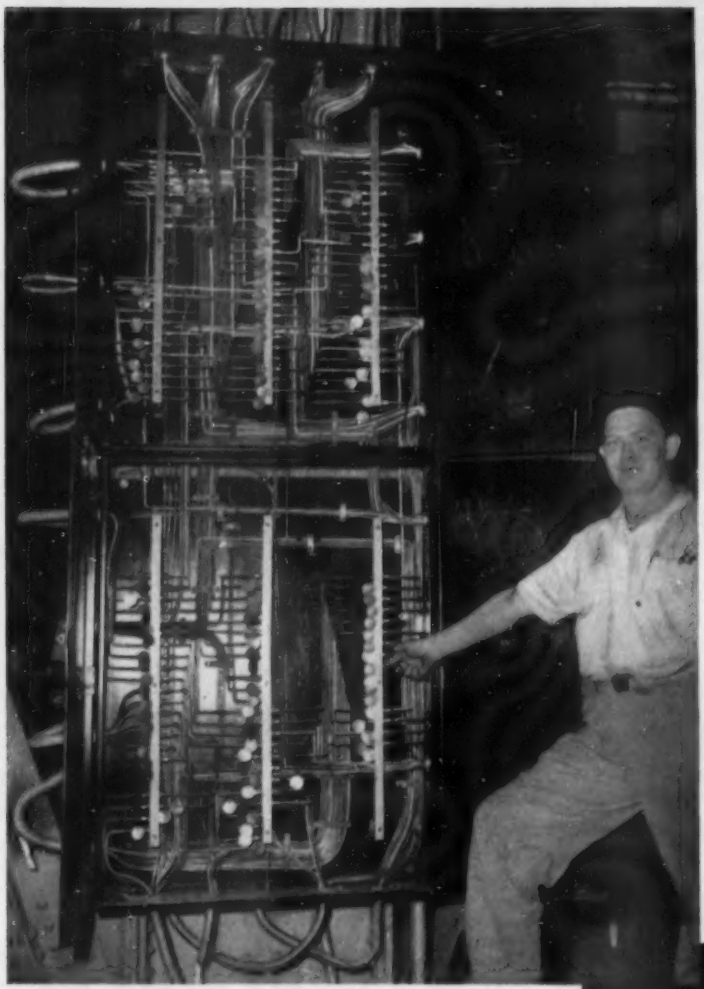
These direct lift units are made in brass *Type F* and stainless steel *Type G*. They have renewable metal seats and coils, are interchangeable with those of other valves in the company's line. Coils are protected for one year by an unconditional guarantee. Silicone coils for high temperature applications are available on both type valves.

J D Gould Co, 730 E Washington St, Indianapolis 2, Indiana

For more data on these items, use post cards, p 175. Identify your request with item number.

FOR INSTRUMENTATION AND CONTROL

Cabled Tube



Some time ago Revere ran an advertisement featuring Crescent Armored Multitube for use in pneumatic and hydraulic instrumentation and control systems. The advertisement created so much interest that we thought you might like to see a photograph of an actual installation. The Control Board Junction Box shown here has 22 runs of Multitube coming into this box comprising 224 Revere Copper Tubes of 1/4" O.D. The picture was taken in the Glenwood Landing, N.Y. Power Station of the Long Island Lighting Company. The tubes go to instruments that report information on temperature, main and reheat steam pressure, boiler feed and condensate pump pressure, fuel oil and gas pressure, liquid levels, tide level and for the control of fuel feed, draft dampers, boiler drum water level and various control valves.

This is a relatively new use for Revere Copper Tube, but it is an important one in these days when new ways are being found to obtain process information more quickly and accurately, or to achieve automatic control. Crescent Armored Multitube is made by Crescent Insulated Wire & Cable Co., Inc., Trenton 5, N.J., in lengths up to 1,000 feet. It consists of a group of long tubes twisted together in cable form, protected by a flexible interlocked galvanized steel armor, or by plastic, or both. As many as 19 tubes, 1/4" O.D., can be cabled, with one tube in each layer color-coded. Larger tubes can also be cabled, including 5/16", 3/8" and 1/2". This construction affords protection during shipment, installation and use, and speeds up installation greatly. For further information, write Crescent, and for tube in copper and aluminum, see the nearest Revere Sales Office.

REVERE

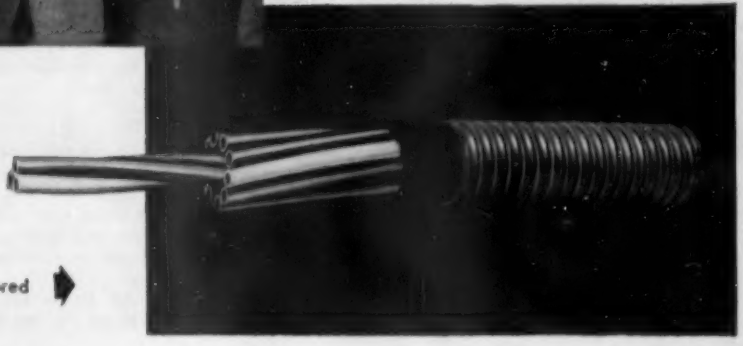
COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

Control Junction Box at Power Station of Long Island Lighting Company, showing use of Crescent Armored Multitube. Note that relatively sharp bends can be made without damage to the cabled copper tube.

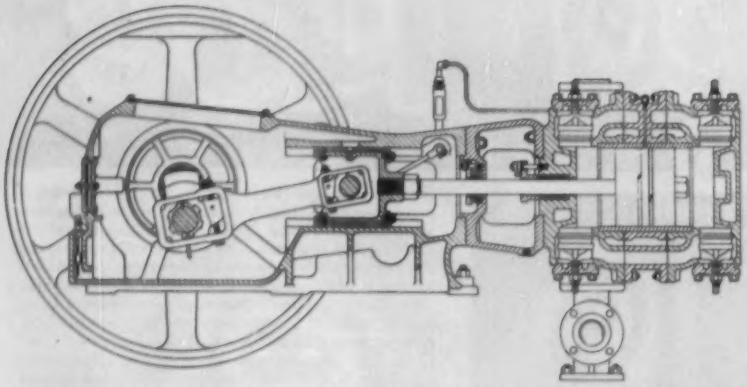


Construction of Crescent Armored Multitube.

More EQUIPMENT NEWS

Begins on page 166

Latest compressor...



Compressor design requires less cooling water, lower horsepower

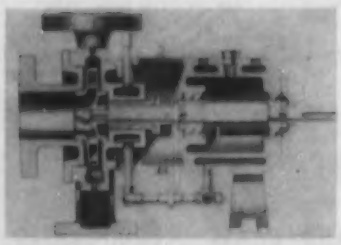
313 • Water-cooled air and gas compressors have sectionalized cylinders arranged in three pieces. Cylinder may be disassembled and liner removed without disconnecting inlet or discharge air piping. Cleaning and inspection is thus eased.

Counter-flow of cooling-water from bottom of one head over and out the top of other head creates improved cooling efficiency, manufacturer states. This arrangement plus increased cooling-area adjacent to valves results in reduction of cooling-water needed to maintain temperature.

Improvement in heat transfer allows unit to operate at lower temperatures; thus making it possible to realize savings in horsepower required for operation. Request bulletin 601 for further details.

Pennsylvania Pump and Compressor Company, Erie, Pennsylvania

...and pump developments

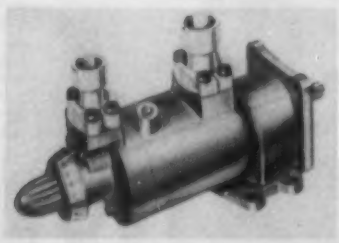


Centrifugal process pumps

314 • Re-engineered and completely integrated line of single-stage, end-suction process pumps feature interchangeability of parts. For example, in *R-10 series*, there are 11 pumps ranging in size from 1 x 2 in. to 4 x 6 in. Yet, manufacturer states, one standard cradle assembly serves for all 11 pumps. Size and capacity of each pump is determined by variations in size of 3 parts —casing, impeller and suction nozzle.

For high temperature service to 850 F, three series with a total of 32 pumps are available. Capacities for these units range from 3 to 7000 gpm. The same pumps are available and interchangeable in three companion series for temperatures to 350 F. Details on request.

Dean Brothers Pumps Inc, 323 W 10th St, Indianapolis, Ind.



Variable delivery pumps

315 • Units are designed for hydraulic systems requiring constant high pressures with control of fluid delivery from 0 to full flow. Two types are available: *Series PVM-600*, equipped with handwheel control for manual adjustment of output; *Series PVC-600*, with a pressure compensated control for automatic regulation of pressure and flow.

Generating continuous duty pressure to 5000 psi, units deliver 3.0 gpm at 1200 rpm. At maximum continuous speed of 2000 rpm, and full-rated pressure, they deliver 4.0 gpm.

Pumps are of axial piston type, with 9 equally spaced pistons in a fixed cylinder block. Full details available on request to manufacturer.

Dudeo div, N. Y. Air Brake Co, 1700 E 9-Mile Rd, Hazel Pk, Mich.

High-capacity chlorinator

316 • High-capacity solution feed type chlorinator is constructed entirely of corrosion-resistant materials. Manual adjustment of chlorine gas injection is made by rate valve on front of cabinet. Actual flow rate is observed through glass flow meter. Six metering tube and float combinations, interchangeable from cabinet front, provide 10 to 1 or greater overlapping flow ranges. Minimum flow is 100 pounds per day, maximum is 8000 pounds per day.

Fischer & Porter Co, 296 Jacksonville Rd, Hatboro, Pa.

Level control electrodes

317 • High-pressure liquid level control electrodes will withstand pressures of 4000 psi and temperatures to 800 C, manufacturer states. Units utilize an aluminum oxide insulator of better than 95% purity with 200,000 psi compressive strength. They are equipped with connecting nuts for attaching probes of any length or shape. Dimensions and further information on request.

Auburn Spark Plug Co, Auburn, New York

Oil-mist, smoke collector

318 • Self-contained unit provides for elimination of oil-mist and smoke at the source. Designed to be mounted on or near high-speed grinding and cutting machines, unit removes over 90% of oil-mist and smoke and returns clean air to the shop. Oil-laden air is drawn in at unit base and metal chips and abrasives are screened. Mist particles are positively charged in ionizing section of cell. Negatively charged collector plates then attract and separate oil from air stream. Clean air continues through.

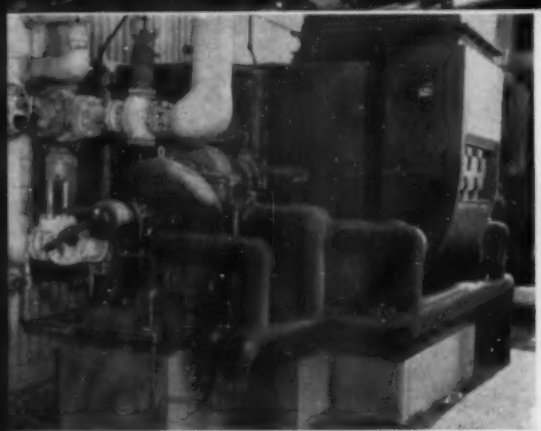
When oil accumulates on plates in droplets heavy enough to resist air stream, it drops off bottom edge passing through a screen into a reservoir. Collected oil can be stored in reservoir or piped back to machine. Further information in manufacturer's bulletin 420.

Dollinger Corp, 11 Centre Park, Rochester 4, New York

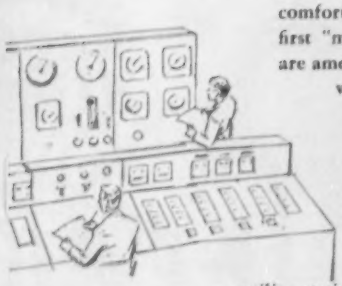
For details on these items use post cards p. 175. Identify request with item number.

CHECK THESE TOO . . .

Forged steel trap . . . . . p 180
Hand and foot valves . . . . . p 182
Dust collecting unit . . . . . p 184
Heavy-duty gear units . . . . . p 186
Low-pressure oil burner . . . . . p 188
Steam and water mixer . . . . . p 190
Distribution panelboards . . . . p 192
Storage batteries . . . . . p 196
Deaerating heaters . . . . . p 198
All-purpose arc welder . . . . . p 200



DELIVERING FAITHFULLY TO MEET PEAK LOADS...



"BUFFALO" DRAFT FANS have been giving that instant, comforting response to load demands, ever since draft was first "mechanized". Knowing that mechanical draft fans are among the most vital pieces of power plant equipment, we have always concentrated on building performance — reliability — and long life into these fans. We call this standard of construction the "Q" Factor*. Though sometimes higher in first cost, it has paid for itself over and over in cheaper, more dependable power production in countless installations. At left is a turbine-driven "Buffalo" Induced Draft Fan in an important utility station. Write today for Bulletin 3750 for full details.

** The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

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488 BROADWAY BUFFALO, N.Y.

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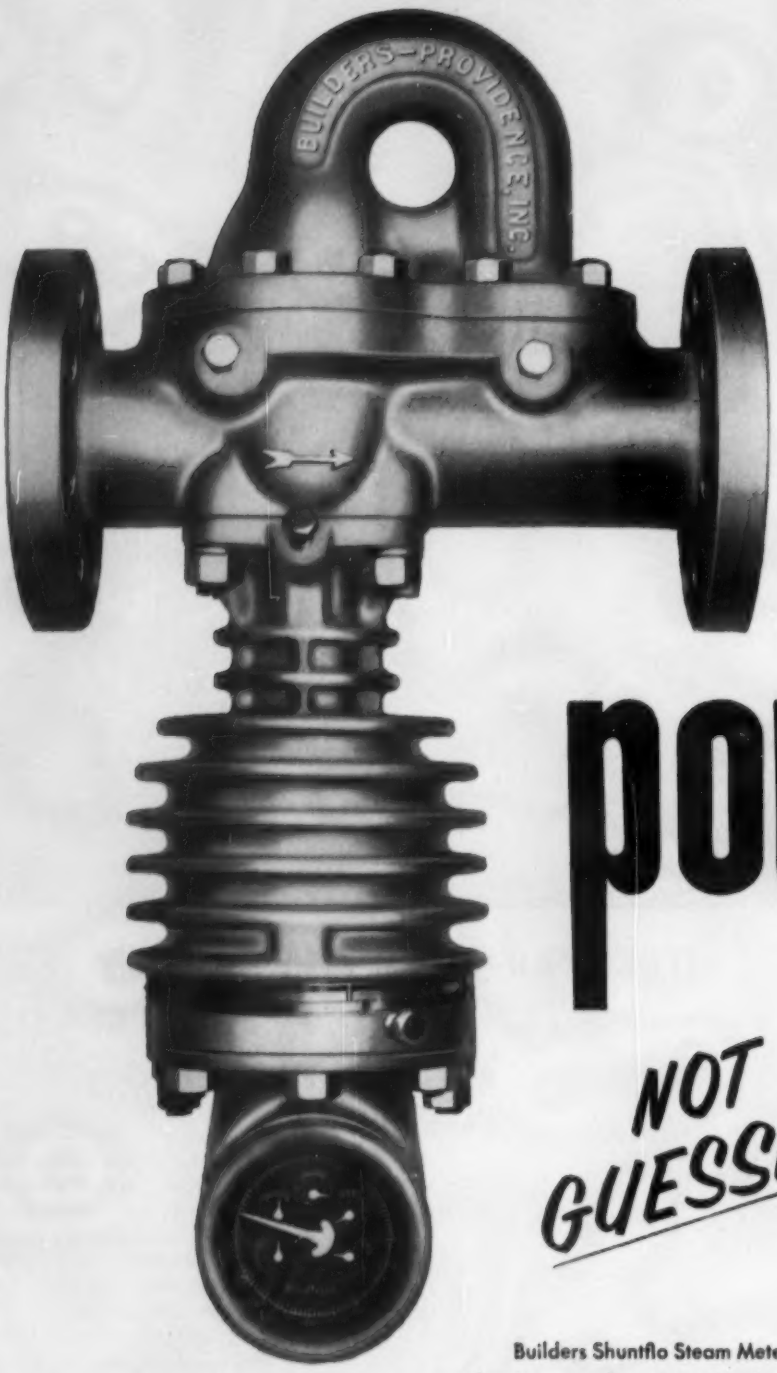

pounds

NOT GUESSES

Builders Shuntflo Steam Meter keeps track of steam costs by showing you *where* steam is going and *how much*. Write for Bulletins. Builders-Providence, Inc., 354 Harris Ave., Providence 1, R. I.

BUILDERS-PROVIDENCE

DIVISION OF B-I-F INDUSTRIES, INC.

BUILDERS IRON FOUNDRY • PROPORTIONEERS, INC. • OMEGA MACHINE CO.

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AIR CONDITIONING AND HEATING

1 **Liquid chillers** for air conditioning and industrial application. Packaged units range from 7½ to 150 hp. Specs, dimensions, in illustrated 16-page bulletin C-1100-B52. Worthington Corp, Harrison, N. J.

2 **Cooling towers** to handle air conditioning loads of 75 tons and up. Photos, cross-section, capacity table in 4-page bulletin 5.1.902. J F Pritchard & Co of California, 4625 Roanoke Pkwy, Kansas City 12, Mo.

3 **Air conditioning** and refrigeration equipment. Photos, product listings in 8-page bulletin 195-C. Frick Co, Waynesboro, Pa.

4 **Converters**—space heating water heaters. Specs, selection data, dimensional table, capacities in 32-page bulletin 54-77. American District Steam Co, Inc, N Tonawanda, N. Y.

BOILERS AND AUXILIARIES

5 **Boilers** and water heating products described in 32-page general catalog 80. Includes data on high and low pressure steel boilers, indirect water heating coils, boiler support brackets, induced draft fans, etc. Kewanee-Ross Corp, Kewanee, Illinois.

6 **Refractory linings** for watertube boilers. Construction advantages, illustrations, data on plastic firebrick, castables, brackets and supports. 12-page bulletin WTB-1/8-540510. A P Green Fire Brick Co, Mexico, Missouri.

7 **Super refractories.** Physical and chemical properties described in 24-page bulletin 5056. Photos, applications, charts and tables. The Carborundum Co, Refractories Division, Perth Amboy, New Jersey.

8 **"Scavenging oxygen** in high pressure boilers" is subject of 2-page data sheet D-54-3. Discusses use of hydrazine in treating feedwater. Milton Roy Co, Station 5A, 1300 E Mermaid Lane, Philadelphia 18, Pennsylvania.

ELECTRIC CONTROLS

9 **Oil circuit breakers,** rated at 14.4 kv, 100,000 kva; 14.4 kv, 250,000 kva and 23 kv, 250,000 kva. Design features, ratings, dimensions and weights in illustrated 8-page bulletin 71B7946A. Allis-Chalmers Manufacturing Co, 983 S 70th St, Milwaukee, Wisconsin.

10 **Oil-tight pushbuttons,** selector switches and accessories described in illustrated 16-page bulletin GEA-5779B. General Electric Company, Schenectady 5, New York.

11 **Line-voltage regulator** for handling loads to 6 kva for 115-v model or 5 kva for 230-v model. Photos, specs, applications in 4-page bulletin 874-A. General Radio Co, 275 Massachusetts Ave, Cambridge 39, Mass.

12 **Power operators** for throttling control service. Applications, specs, dimensions in illustrated 12-page bulletin B-50-2. Conoflow Corp, 2100 Arch St, Philadelphia 3, Pa.

13 **Automatic control system** with remote transmission, designed exclusively for water and sewage systems. Photos, diagrams in 8-page bulletin 5100. Automatic Control Co, 1005 University Ave, St Paul 4, Minn.

SAFETY EQUIPMENT, MATERIALS

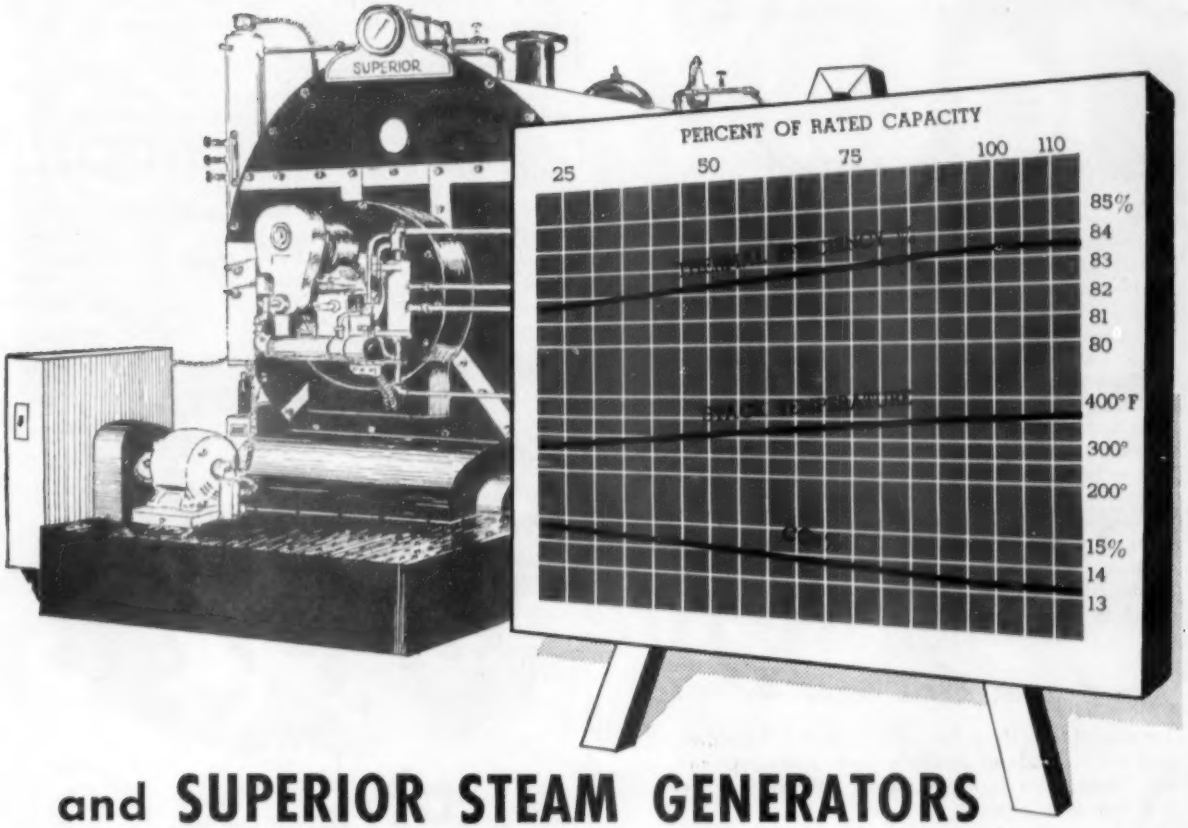
14 **Protective headgear,** first-aid packs, safety hooks, respiratory equipment, safety belts, and related equipment described in 20-page bulletin 55. E D Bullard Co, 275 8th St, Dept 531, San Francisco 3, Calif.

15 **Fire-resistant fluid** *Pydraul F-9* for hydraulic equipment operating near possible sources of ignition. Illustrations and charts in descriptive 20-page bulletin. Organic Chemicals division, Monsanto Chemical Company, 800 N 12th St, St Louis 1, Missouri.

(*Continued on page 224*)

PERFORMANCE

is part of the PACKAGE



and SUPERIOR STEAM GENERATORS are rated for actual operating conditions

Superior Steam Generators are fully automatic, burning oil or gas or both. 18 sizes from 20 to 600 b.h.p. for pressures to 250 p.s.i. or for hot water. Write for catalog 700.

The payoff in performance is in your plant—here is where a steam generator must live up to the claims of its maker or you are the loser. Every Superior Steam Generator is "Performance Rated" on the basis of tests conducted under conditions duplicating those of actual service and is guaranteed on the results of these tests. The chart above shows typical performance of a Superior Steam Generator at 100 lbs. pressure. It is based on tests conducted by professors from Lehigh University on a boiler which had been in actual service for over a year. You can depend on results like these throughout a longer serviceable life when you specify Superior Steam Generators.

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STEAM GENERATORS

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

George Edwards' Scrapbook

Let's stop these headaches

Most power engineers know by now that the atomic submarine *Nautilus* was delayed for months because of steam-piping failure. The manufacturers tested each piece of high-pressure, high-temperature pipe in the presence of government inspectors. So far, so good.

But when the material arrived at the submarine building yard, it was stored next to ordinary pipe. Because the two stacks were not clearly labeled, yard mechanics used material from the wrong pile. As a result, all the main-steam lines had to be removed from the submarine. Joker is that to get to those lines, many other lines, cables and equipment had to be removed from inside the highly compact vessel.

This is an old story to every power engineer. We have all seen expensive damage from welding beads left in pipelines, or from new equipment started without proper precautions. When will we learn to supervise each step in a construction or maintenance job until everything is buttoned up and ready to run?

Said your kind word today?

Let your virtues, if you have any, speak for themselves, and refuse to talk of another's vices. Discourage gossip. Make it a rule to say nothing of another unless it is something good.

More on retirement

Retirement should be easier for engineers because most of us have imagination. Now Fred Annett, your contributing editor, is most fortunate because he has been an associate editor, and can continue writing at home or anywhere.

My idea is to work at something creative that my wife is also interested in. When the kids grow up and leave home, a wife is in the same boat as her retired husband —in a way.

One retired engineer I know works in real estate when he feels like it. Another spent a number of his earlier years designing and perfecting a tool to manufacture after retiring. Now at 72 he is doing real well.

I believe you must think about and plan retirement for some time in advance to make it work. The man who looks at 65 as a "grit and sit" time, or who grows bitter from thinking he is no longer useful, will have to swim in his own troubled thoughts. It won't be easy.

As time passes, I expect to find that more things will have possibilities for my retirement days. While crowding 30, I may not be in the old-timers' class, but these are my thoughts at present. How do other young readers feel?

Cambridge, Minn. DONALD L. COCHRANE

Why not simplify writing?

Difference between a technical paper, read at an engineering society, and an article prepared by a POWER editor results from the editor knowing journalism. Some day I hope to hear a technical paper read as a good editor would edit it. He can take a highly technical paper and translate it into readable sentences.

More than that, he can simplify complex drawings and present them so readers will *want* to look at them. One method is to use tints instead of crosshatching, then put more ink on parts he is talking about. Another is to make live perspective sketches from flat mechanical drawings. Result is an easy-to-understand presentation.

I've often wondered why some manufacturers don't simplify their instructions and drawings. Look at Sears Roebuck catalog. Most items are illustrated with live photos or with sketches of people actually using the product. To me, dead catalog cuts are dull, should be made alive.

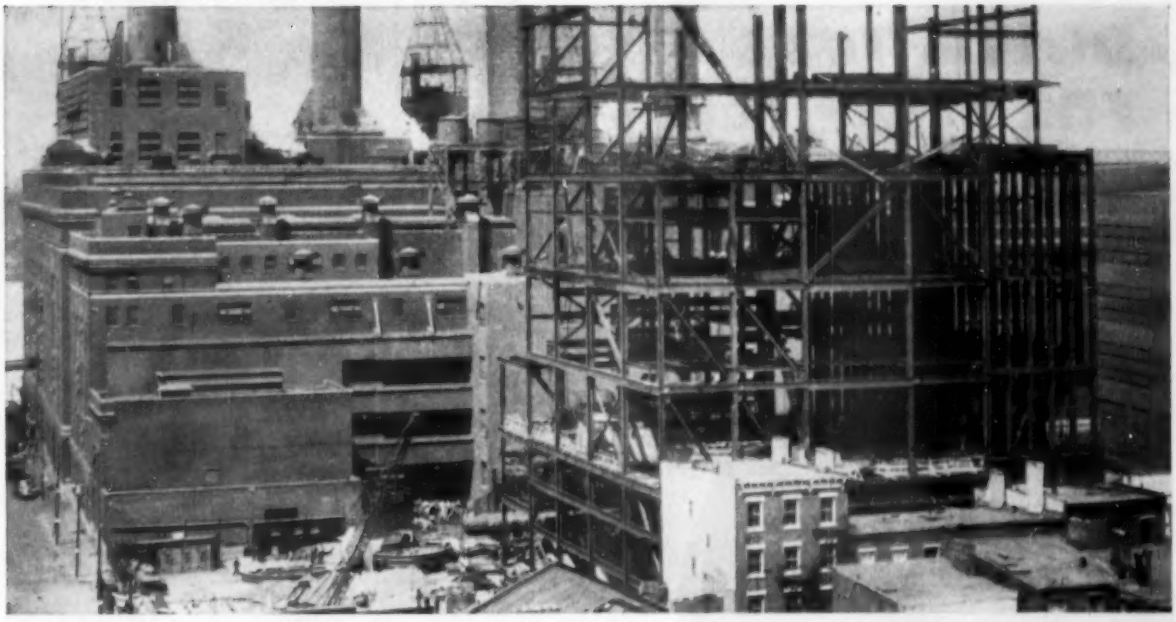
You haven't spare time?

It's the extra work that counts. As Abe Lincoln put it, "A man who earns only what he's paid isn't worth what he gets." If you don't believe that, ask any executive how he gets things done. He tells you he gives the really tough jobs to the busiest man on his staff. The person who has time on his hands isn't doing anything because he can't create his own work—has to be led by the hand—usually has no imagination—chances are he doesn't belong.

No spare time to do the things you like to do? Look at it this way. There are 365 days in a year, or 8760 hours. Deduct 8 hours daily for sleep, or 2920 hours; 40 hours weekly for work (49 weeks) or 1960 hours; 2 hours per day to get to work 490 hours, 3 hours daily for meals is 1095 hours, one hour daily for dressing is 365 hours. All this adds up to 6830 hours, which leaves 1930 hours on your hands.

Using one hour a day for study and extracurricular work will only take away 365 hours. Since time passes any way, why not use this extra time usefully?

George Edwards
Engineer



CHEMICAL CLEANING REMOVED MILL SCALE FROM BOILER AFTER ERECTION

Dowell Service gave quick, effective cleaning assuring more efficient operation

To provide more extensive service for its customers, a large power company installed a new 1,370,000 lb. per hour boiler. Specifications on this equipment called for Dowell Chemical Cleaning Service to remove any oil, grease, protective coatings, mill scale and rust from the boiler after erection.

To accomplish the purpose, Dowell engineers filled the boiler with solvents especially designed for the job. Using Dowell's equipment, manpower and pump trucks, the entire cleaning job was performed in a few hours.

Dowell has removed as much as three thousand pounds of mill scale and iron oxide from a new boiler.

Unless it is removed, mill scale may retard heat transfer, slough off abrading particles, and act as a base for corrosion. And considerable annoyance may result from black boiler water. The removal of mill scale after equipment is erected can also eliminate much of the extra care required in the handling of previously sand blasted or pickled tubes.

Maintenance engineers in industrial plants throughout the country have learned to rely on Dowell Service for fast, effective and economical cleaning of their operating equipment. How about you?

Experienced Dowell engineers are available to make estimates on your particular problems. Call Dowell today, or write to DOWELL INCORPORATED, Tulsa 1, Okla., Dept. C-23.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

NO DOWN-TIME FOR CLEANING WITH THESE

ELLIOTT Strainers

TYPE "A" TWIN STRAINER – for water and other liquids . . . available sizes 4" to 24" for 125 lb. pressure – 4" to 12" for 250 lb. pressure. Straining baskets available with 1/32" to 3/8" mesh. The design completely protects the valve screw from contact with the liquid being strained, protecting it from possible corrosion and physical damage from foreign matter in the liquid.

A replaceable neoprene valve ring in the valve disc cleans the valve seat as the disc moves across it, insuring tightness.

TYPE "V" TWIN STRAINER—Specially designed for lube oil, fuel oil and all viscous liquids. Available sizes 1" to 8" for 125, and 1½" to 10" for 300 and 500 psi. Straining baskets available with 1/64" to 3/16" mesh. This design features oversize straining baskets that lengthen the time between cleaning periods, and keep pressure drop low. An indicator tells which chamber is in operation.

TYPE "K" SELF-CLEANING STRAINER —For removing large amounts of dirt and foreign matter in water only. Can be furnished with A-C or D-C motor. Available sizes 4" to 24" for pressures from 25 to 125 psig. Straining baskets available with mesh hole dia. 1/32" to 3/8". This strainer cleans itself continuously by back-flushing each straining unit in turn, with a constantly rotating element turning in a cutless rubber guide bearing, and supported by an external roller thrust bearing. The power requirement does not exceed ½ hp in the largest size.

WITH THESE sturdy, dependable Elliott Strainers, there's no need to stop liquid flow for cleaning purposes. The type "K" cleans itself constantly and automatically. Type "A" and "V" are Twin Strainers – while one compartment handles the flow, the other is available for cleaning. In addition, minimum resistance results in low pressure drop . . . cleaning is quick and easy . . . and mechanical servicing is simple. Where the flow can be stopped temporarily for removal and dumping of the basket, Elliott Single Strainers may be used. For details about the Strainer you need, contact your local Elliott Field Engineer, or write Elliott Company, Accessories Dept., Jeannette, Pa.

A4-1

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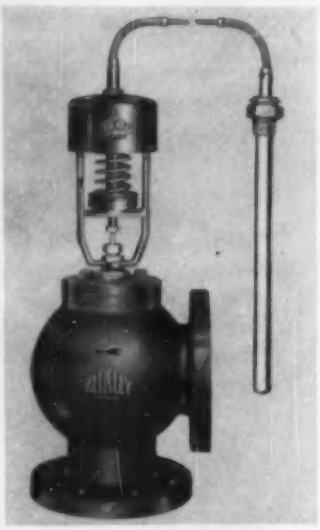
STEAM TURBINES • MOTORS • GENERATORS • REGENERATIVE HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOSUPERCHARGERS • TUBE CLEANERS • STRAINERS

More EQUIPMENT NEWS

Begins on page 166



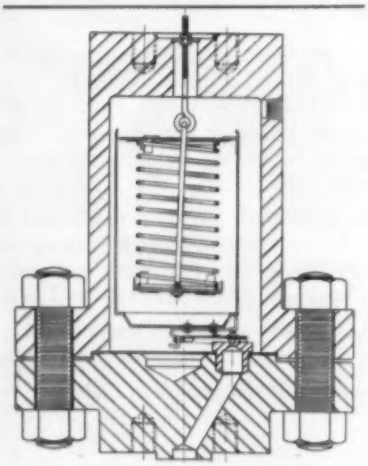
Angle temperature regulator

340 • *Type T* temperature regulators may be mounted directly on heat exchangers, instant water heaters, etc, that have inlet connections on top, thus saving piping and installation labor. Unit has "over-run" feature for protection of thermal element in event temperature at bulb exceeds range of regulator. A two-ply bellows is used in thermal unit for added power and longer life.

Body is bronze or semi-steel. Trim is either bronze or stainless steel. It is available with screwed connections in sizes from ⅛ to 2 in. and with flanged connections in sizes from 2 to 8 in.

O C Keckley Company, 400 W Madison St, Chicago 6, Ill.

For more data on these items, use post cards p 175. Identify your request with item number.



Forged steel trap

341 • Unit is designed for draining water from compressed air or gas systems at pressures to 3000 psig where no gas loss is permissible. Trap features spring-balanced open float that normally holds valve closed by weight of water in bucket com-

"BIG ROCKER"

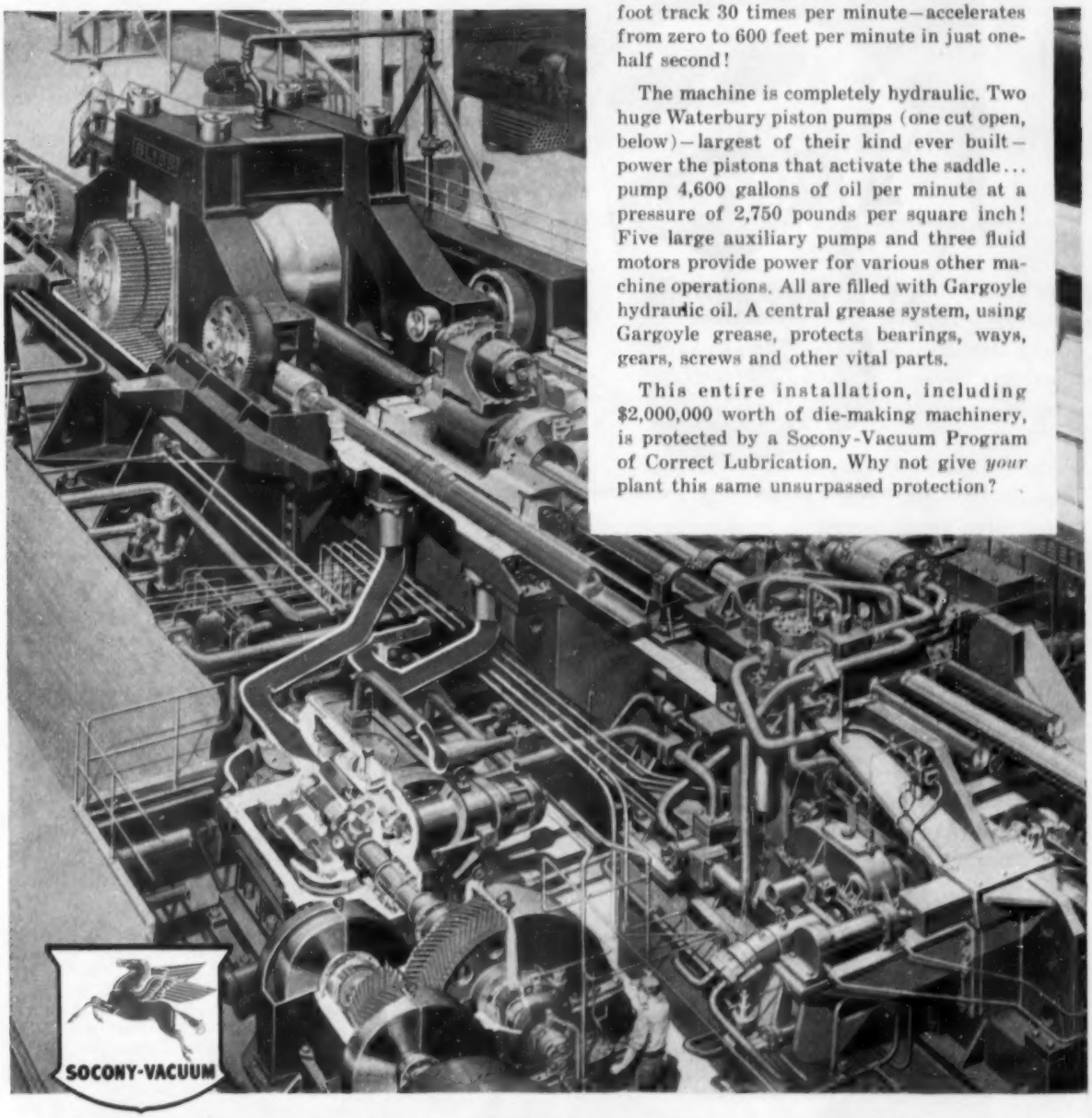
World's Largest Tube Reducing Machine Protected by the World's Greatest Lubrication Knowledge

It's 100 feet long, three stories high, weighs 675 tons! It's the world's largest tube reducing machine, built by E. W. Bliss Co., for the Tube Reducing Corp., Wallington, N. J. This giant takes rough, 18-inch O. D. cold steel tubing and reduces it to between 17- and 9-inch tubing. Finished tolerances are precise.

Heart of the Big Rocker is the "saddle" (top) which holds the huge dies that shape and stretch the tubing. This saddle, weighing 152 tons, rocks back and forth on a six-foot track 30 times per minute—accelerates from zero to 600 feet per minute in just one-half second!

The machine is completely hydraulic. Two huge Waterbury piston pumps (one cut open, below)—largest of their kind ever built—power the pistons that activate the saddle... pump 4,600 gallons of oil per minute at a pressure of 2,750 pounds per square inch! Five large auxiliary pumps and three fluid motors provide power for various other machine operations. All are filled with Gargoyle hydraulic oil. A central grease system, using Gargoyle grease, protects bearings, ways, gears, screws and other vital parts.

This entire installation, including $2,000,000 worth of die-making machinery, is protected by a Socony-Vacuum Program of Correct Lubrication. Why not give *your* plant this same unsurpassed protection?



SOCONY-VACUUM *Correct Lubrication*

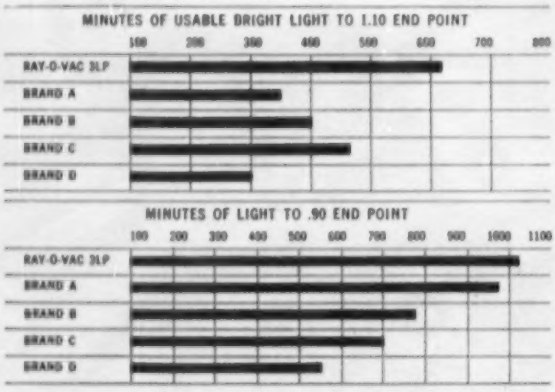
FIRST STEP IN CUTTING COSTS

SOCONY-VACUUM OIL COMPANY, INC., and Affiliates: MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORPORATION

newest and finest!

Industrial Flashlight Battery

Here are amazing comparative* performance figures!



Here's a truly new, *performance-tested* Industrial Flashlight Battery! Available now in the famous patented Ray-O-Vac sealed-in-steel construction . . . and at no extra cost! Here's a battery that *always* gives longer usable light time! Like all Ray-O-Vac LEAK PROOF Brand batteries the No. 3LP is fully guaranteed against corrosion because it's sealed in steel—top, bottom *and* sides.

RAY-O-VAC COMPANY

Madison 10, Wisconsin

Ray-O-Vac Canada, Ltd., Winnipeg, Manitoba

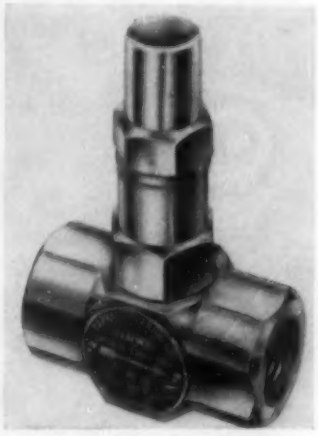
*Figures obtained from tests conducted under specifications established in Circular of National Bureau of Standards No. C-466.

More EQUIPMENT NEWS

Begins on page 166

pressing the spring. Entering condensate fills trap body, adding buoyancy to the float. Buoyancy plus spring compression then overcomes weight of water and bucket. Bucket floats, opening valve and allowing condensate to discharge. Water sealed valve closes before all the water is discharged. Capacity at 2000 psig is 2000 lbs/hr.

Armstrong Machine Works, Three Rivers, Michigan

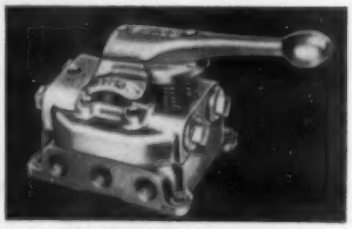


Impulse steam trap

342 • *Model 20A* ½-in. impulse steam trap is designed with low capacity to handle light condensate loads. Manufacturer states that unit will not freeze or air bind on steam tracer line service. Body and all working parts are made of stainless steel. Unit handles all pressures to 400 psi.

Yarnall-Waring Co, 100 Mermaid Ave, Philadelphia 18, Pennsylvania

For more data on these items, use post cards p 175. Identify your request with item number.



Hand and foot valves

343 • These *880 Series* valves are available with single or double foot treadle and vertical or horizontal hand lever controls. They are easily changed from hand to foot operation. Separate base for bottom or side ports is provided and an optional base is available to permit manifolding a series of bases for simplified piping. Pressure rating is 125 psig and maximum recommended operating temperature is 175 F. Details on request.

Ross Operating Valve Co, 120 E Golden Gate, Detroit 3, Michigan

Automatic bleeding valve

344 • Self-bleeding valve is said to constantly and automatically bleed air out of a hydraulic system while the system is in

Chapman List 960

...for EVERY Small Forged Steel Gate Valve Application

Month after month, Chapman List 960 Valves deliver the goods on more different jobs than any other small forged steel gate valves. And maintenance charges are few and far between even under the toughest conditions.

The wedge gate faces — hardened to 800 Brinell by Chapman's exclusive Malcomizing process — won't seize or gall. Seat rings are hardened stainless steel, for minimum wear, and are easy to replace. Also, the bolted follower has no exposed threads on the yoke to corrode.

For every small forged steel gate valve application, specify Chapman List 960. Sizes from ¼" to 2", either rising stem with yoke (shown) or rising stem with inside screw. Bonnet joint is ground metal-to-metal or gasketed, depending on application. Pressure range is from 380 psi at 1000°F to 2000 psi at 100°F. For higher ratings, specify List 990.

List 960 is made in various alloys and combinations of alloys as listed in Catalog No. 10. Write for your copy today.

The CHAPMAN Valve
Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS

ONE CONTROL DOES 2 JOBS

MERCOID DA-400 SERIES

Pressure Controls are dual purpose controls, incorporating a single pressure element operating two separate, independently adjustable Mercoid magnetic switches. The switches may be used for multiple circuit control for various operations as the control responds to pressure changes.

For example:

- Close one alarm circuit at high pressure and another at low pressure with both circuits open over operating range.
- As an electrical interlock to open one circuit as pressure rises above and the second circuit as the pressure drops below operating range.
- To provide two-stage control by opening or closing one circuit on a rise in pressure and the second circuit on a further rise in pressure.

AVAILABLE IN 17 PRESSURE RANGES

0-30" VAC. TO 300-2500 PSI.

Equipped with calibrated dial and outside adjustments

Our engineers are at your service—send in your control problem or

WRITE FOR BULLETIN NO. 92.

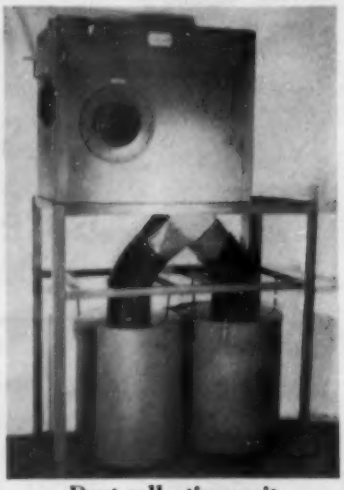
THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.

More EQUIPMENT NEWS

Begins on page 166

operation. Units are connected adjacent to entrance ports of hydraulic cylinders. Applications include automotive and industrial brakes, machine tools, bucket loaders and other earth moving equipment, and devices utilizing hydraulic power.

Radial Metal Products, Inc, 1044 Linwood St, Brooklyn 8, New York



Dust collecting unit

345 • Recent changes in *Dustkop model 11w50* have resulted in a more efficient and easily maintained unit, manufacturer states. Overall height has been reduced by elimination of standard dust bin. Filtered dust, shavings, chips or lint drop directly into selected collecting roller cans. Two roller cans plus diversion "Y" have been redesigned to permit greater capacity and ease of maintenance. Full details on request.

Aget Mfg Co, Adrian, Michigan

For more data on these items, use post cards p 175. Identify your request with item number.

Enclosed vibration mountings

346 • Spring type vibration unit *Type SF* is of telescopic construction, fully enclosed in semi-steel housing. Steel spring mounting is said to permit greater deflections necessary for high isolation efficiency. Units offer increased carrying capacity without increase in physical size, according to the manufacturer.

Full enclosure prevents oil, wastes, cuttings, etc from clogging springs or working parts. Protected resilient guides offer all-

ALLPAX

Reg. U.S. Pat. Off.

The "Packing that packs ALL"

... for longer life at lower cost ALLPAX SHEET PACKINGS have won the recognition and acceptance of many large plants

No. 500 Superheat

For steam pressures to 400#; temperatures to 700°.

No. 600 Oil proof

For hot or cold water, hydrocarbons, aldehydes, keytones (except Acetone), compressed air, carbon dioxide, formaldehyde, etc.

Red Rubber

For hot and cold water, air and low pressure steam.

Diaphragm Sheet Packing . . . Cloth Inserted Sheet Packing.

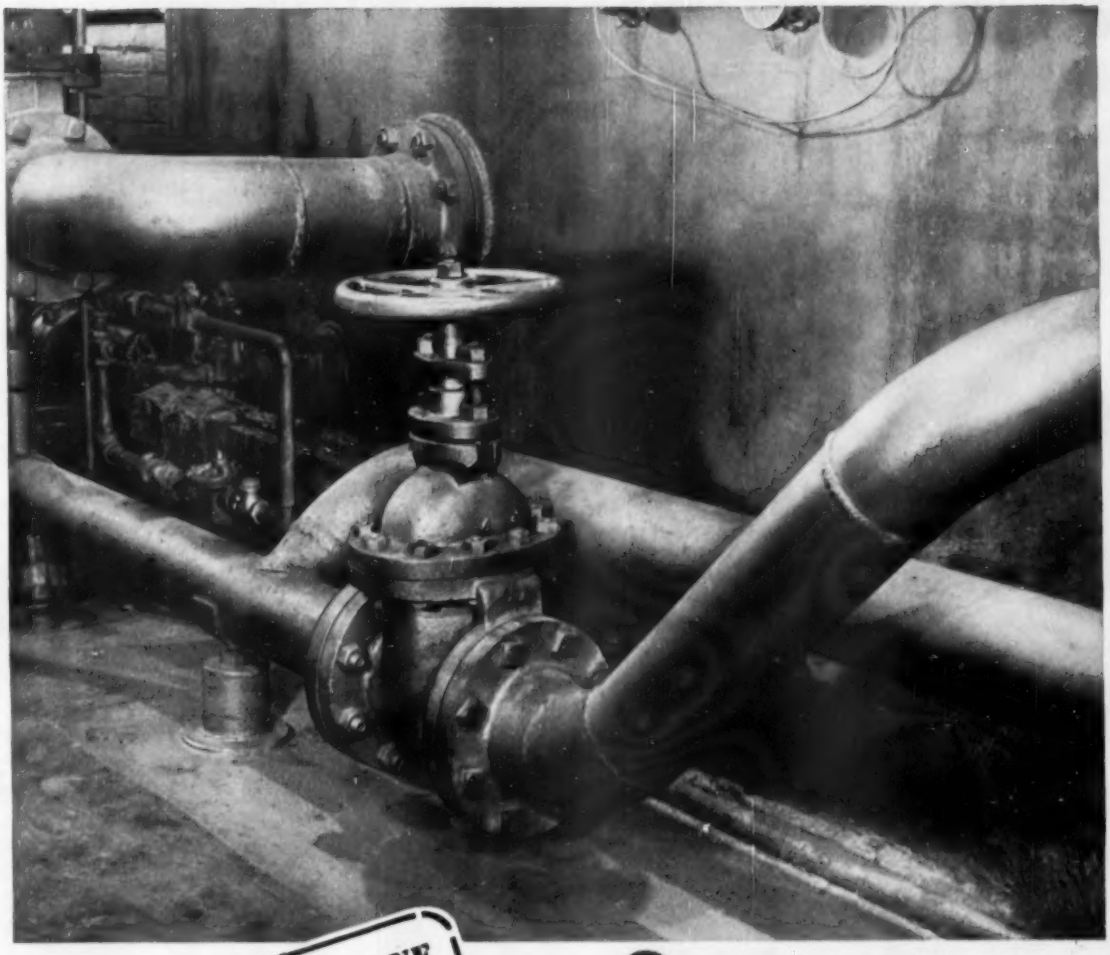
Cut your own gaskets from these materials (also bolt holes) with ALLPAX GASKET CUTTERS. Be assured of maximum service at lower cost from these packings which remain pliable and resilient and do not deteriorate with age.

THE ALLPAX COMPANY, INC.
805 MAMARONECK AVE.
MAMARONECK, N. Y.

Also Packings in coil, ring or loose form; Valve Discs, Retainer Packing, Molded and Mandrel Cut Packing Rings, Packing Hooks; Gasket Cutters.

Send for catalog; contact your nearest distributor.

How to cut corners that cost



ANOTHER JOB DONE BETTER WITH GLOBE WELDING FITTINGS

PIPING "corners" can be costly—costly in initial installation, continual maintenance, flow resistance, pressure-loss, erosion, and corrosion.

You can "cut the corners that cost" with Globe Welding Fittings. Installation is simpler—faster. Your piping is safer, stronger with less weight—needed space reduced —insulation is easier and faster. There is less chance for erosion, corrosion, and leakage to develop because of the smooth inner walls, true radii and circularity of Globe Welding Fittings. Liquids and gases flow smoothly with less resistance and pressure-loss.

Decide to "cut the corners that cost" on your next piping job — specify and use Globe Precision-Process Welding Fittings.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Fittings Department
3839 W. Burnham St. • Milwaukee 46, Wisconsin

B&W SEAMLESS and WELDED TUBES

MEGGER® ELECTRICAL INSULATION TESTERS

Ratings up to 2000 Megohms and 1000 Volts DC

...in types to suit varying needs of ELECTRICAL MEN for Shop and Field Use

HAND CRANK MEG TYPE of Megger Insulation Tester is a reliable field instrument, light, sturdy, with a constant-voltage type generator—no dependence on batteries or other current supply. By far the most popular instrument among electrical plant maintenance men. Easy to use—easy to read—and rugged in constant services. **BULLETIN 21-45-P.**

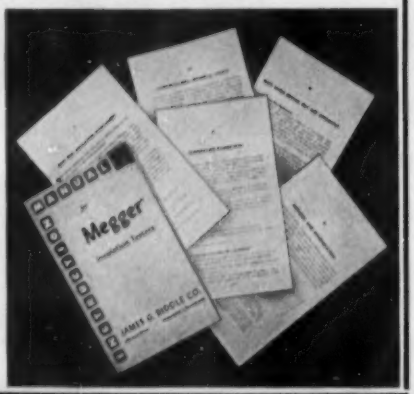
RECTIFIER OPERATED MEG TYPE of Megger Insulation Tester simply plugs into a convenient outlet. Portable or flush bench-mounted. A dependable production or inspection instrument. Quick, easy readings speed up otherwise costly tests.

DUAL-OPERATED MEG TYPE of Megger Insulation Tester may be operated by hand or rectifier. Excellent solution for those requiring a versatile instrument for field and bench use. **BULLETIN 21-46-P.**

HELPFUL, FILEWORTHY DATA

on ELECTRICAL PREVENTIVE MAINTENANCE

The new Fifth Edition of the Instruction Manual for Megger Insulation Resistance Testers is expanded to 100 pages. Fourteen chapters are devoted to a complete education for the practical man who is responsible for electrical equipment. Ideal for classroom or staff instruction. Your copy will be mailed free if you write on your company letterhead for **MANUAL 21-J-P.**



JAMES G. BIDDLE CO.

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James G. Biddle Co.
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Please send me material checked:
☐ 21-45-P ☐ 21-46-P
☐ 21-J-P

NAME
JOB FUNCTION
COMPANY
ADDRESS

More EQUIPMENT NEWS

Begins on page 166

direction snubbing and damping. Inspection window permits checking of adjustment and operation. Details on request.

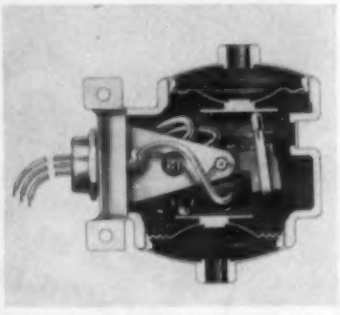
Vibration Mountings, Inc, 76-19 Queens Blvd, Elmhurst 73, L. I., N. Y.

Heavy-duty gear units

347 • Units can accommodate rotating speeds to 9000 rpm and pitch line velocities to 10,000 fpm without modification. Recommended applications include service with turbine drives, test stand drives and air conditioners. Units are manufactured in 17 sizes for ratings to 7100 hp and are available in any specified ratio from 1:1 to 10:1. Gearing is double opposed helical type having teeth hobbed and precision shaved. Opposed helices eliminate thrust forces against bearings and housings. Catalog HI-542.

Philadelphia Gear Works, Inc, Erie Ave & G St, Philadelphia, Pa.

For more data on these items, use post cards p 175. Identify your request with item number.



Pressure difference switch

348 • Unit senses any pressure difference from 0 to 99 psi between two pressures within working range of .05 to 100 psi, according to manufacturer. The switch will actuate an electric circuit on increase or decrease of any predetermined pressure difference within range of selected unit. Functions of switching or pressure sensing elements are reported unaffected by jarring on mobile installations or by vibrations from pumps and compressors.

Barksdale Valves, 5125 Alcoa Ave, Los Angeles 58, California

Selenium rectifiers

349 • Designed for industrial applications, units are claimed to have a power factor of 97% and dc ripple of approximately 4%. Models available for use as

DETROIT ROTOSTOKERS SATISFY

Write for this reprint today

This article should interest you.

It tells how the Chesterfield Richmond plant was modernized. A Detroit RotoStoker fired Babcock and Wilcox Integral-Furnace boiler increased the steam-coal rate from 7.6 to 11.7.

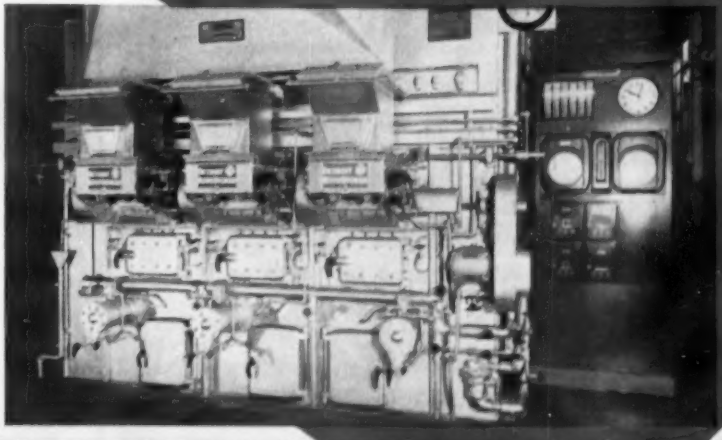
Detroit RotoStokers will save you money. Contact our nearest district office or your consulting engineer.

"They Satisfy"

Detroit RotoStoker at Liggett & Myers Tobacco Company Richmond, Virginia Plant

•

Lockwood Greene Engineers Inc. Consultants . . . New York

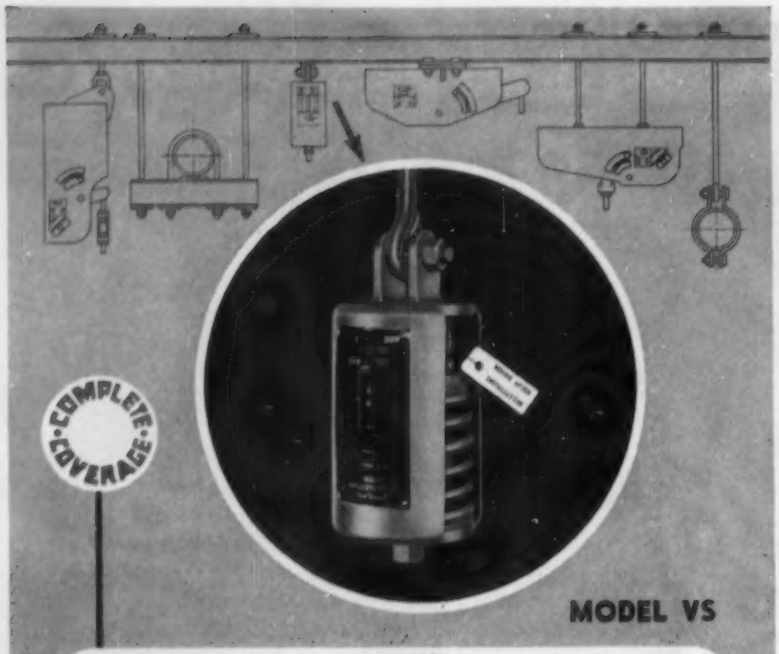


DETROIT STOKER COMPANY

General Motors Building—Detroit 2, Michigan

District Offices in Principal Cities • Works at Monroe, Michigan

DETROIT *SINCE 1898* **STOKERS**



This is article number 5 in a series dealing with the subject of pipe supports in modern power and industrial plants.

The Bergen variable support is essentially a housed, precompressed helical spring. It permits thermal expansion while exerting a supporting force upon the pipe dependent upon the compression in the spring.

Our experience has pointed to the need of an improved and more fool-proof spring hanger. To satisfy this need we have developed the new Bergen variable support. In this new design two vertical openings have been provided in the housing thus making it possible to fully inspect all the component parts during manufacture as well as during installation. The hanger so constructed can be easily cleaned of foreign matter or dust which could hinder its proper function. It can be readily pre-set for easy installation and the spring itself is now designed for optimum efficiency instead of being controlled by the fixed diameter of its container.

The spring scale expressed in pounds per inch of deflection, is a basic consideration upon which to select the proper variable support. The "softer" the spring; i.e. the lower the spring scale; the less will be the load variation introduced into the supporting system. This is an important factor for the designer to consider, as improper spring selection can result in excessive transfer of load to critical equipment connections. Also, failure at one support point can induce a chain reaction resulting in widespread failure at many points.

Three tips on selection:

1. *Always state the load in the "hot" position.*
2. *Always give the travel from cold to hot position.*
3. *Remember to divide the total load in half when selecting trapeze assemblies.*

BERGEN PIPESUPPORT CORP.
50 Church Street, New York 7, N. Y.

474

More EQUIPMENT NEWS

Begins on page 166

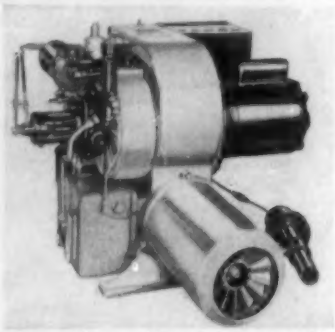
fan-cooled rectifiers, convection-cooled rectifiers and combinations. Any number of units may be paralleled. Complete details on request to manufacturer.

Walker Div, Norma-Hoffmann Bearings Corp, Stamford, Connecticut

tion to 3800 sq ft or 35 boiler hp. The small industrial, commercial and institutional buildings having a net standard radia-

350 • Unit is designed for installation in

Low-pressure oil burner

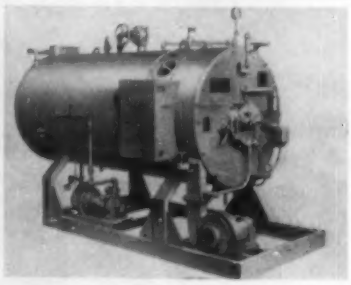


pressure-air atomizing type burner with all electric ignition is capable of burning 11 gallons of oil per hour.

Manufacturer states the packaged unit is inexpensive to install since no front plates, secondary air door or checker work hearth is needed, all primary and secondary air being furnished by the burner. It is designed to burn low cost No. 4 or No. 5 heavy oil without preheating.

Cleaver-Brooks Co, 326 E Keefe Ave, Milwaukee 12, Wisconsin

For more data on these items, use post cards p 175. Identify your request with item number.



Packaged boilers

325 • *Model Y* boilers are available in sizes to 500 hp and pressures to 200 psi. Units use 3-pass design with simple refractory and baffles that ease cleaning and maintenance, manufacturer states. Complete packaged units offer 5-sq ft of heating surface per boiler hp. Details on request.

Ames Iron Works, Inc, Oswego, N. Y.

Separator-type accumulator

332 • Cylindrical double-shell accumulator incorporates floating piston that transmits pressure of precharged gas to working medium and prevents entrainment of gas into hydraulic fluid. Gas is introduced under pressure into outer shell of accumulator. In turn, gas is permitted to enter upper end

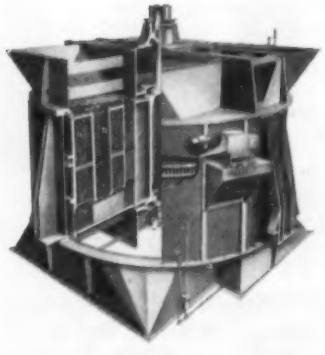
why you need less fuel with the Ljungstrom® Air Preheater

With every 45-50 F of air preheat — you cut your fuel bill 1%. That's why it pays to equip your boilers with Ljungstrom Air Preheaters. For the Ljungstrom is the most efficient air preheater there is.

Advantages of the Ljungstrom Air Preheater

- Size for size, recovers more heat than any other type.
- Reduces fuel consumption. Permits use of lower-grade fuels. Increases boiler output and reliability.
- Eliminates cold spots . . . keeps corrosion to a minimum.
- Easier, faster to clean and maintain.
- Requires far less supporting steel and is quickly erected.

The Ljungstrom also gives industrial plants broad latitude in their choice of fuels. Its unmatched preheating efficiency makes practical and effective such low-grade fuels as saw and paper mill refuse, wood, lignites, peat and bagasse.



Outright fuel economy is reason enough why 7 out of 10 modern preheater installations are Ljungstrom, and why Ljungstrom percentage of installed boiler capacity increases every day. Yet it's just one of the many advantages of the Ljungstrom. Get all the details on why the Ljungstrom cuts fuel costs . . . why it's the most efficient heating surface on the modern boiler . . . why it's easier to clean and maintain. All the details are in the new, 38-page reference manual, "Ljungstrom Air Preheaters." Write for it, today.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

BELMONT
PACKINGS
for WATER...STEAM...OIL...

BELMONT 9 . . . for all hydraulic services from low pressures to extremely heavy duty, hot and cold water.

BELMONT 19 . . . for hot and cold water rods and plungers; low and intermediate steam rods.

BELMONT 30...for high pressure steam rods, expansion joints, air, and gas.

for better sealing—LONGER

Regardless of the temperatures or pressures involved . . . no matter what the lading . . . *your* equipment maintenance costs can benefit from longer, more dependable packing life. If you're *paying* for the best—and you probably are—make sure you *get* it by specifying BELMONT Packings in formulations suited to your particular needs.

Don't make do with the next best—*insist* on BELMONT . . . available in a wide range of materials . . . hundreds of styles and types . . . through distributors everywhere. When it SEALS right—stays TIGHT . . . you know it's Belmont made.

CLIP and Send Coupon 4-R-5

BELMONT PACKINGS

Butler & Sepviva Streets **Philadelphia 37, Pa.**

☐ Crisscross Braid Folder
☐ #54 Condensed Catalog
☐ #40 Catalog

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☐ SEND NAME and ADDRESS of NEAREST BELMONT DISTRIBUTOR

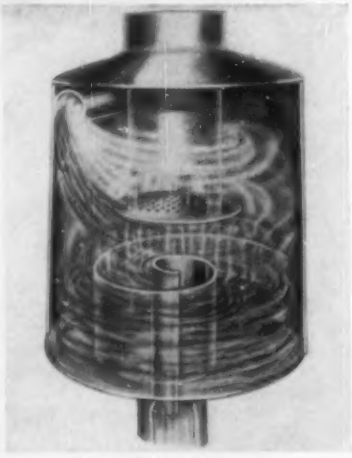
More EQUIPMENT NEWS

Begins on page 166

of inner cylinder. There it exerts pressure against floating aluminum piston. Constant pressure of gas against piston forces it against oil that enters pressure balanced inner shell from main hydraulic line. Pressure of working medium in outlet line is thereby maintained at constant pressure. Unit eliminates necessity of a compressor.

These accumulators are designed for 2000 psi and will deliver 2310 cu in. of oil with pressure drop of 10% and hold a net gas capacity of 21,950 cu in.

Superior Hydraulics div, Superior Pipe Specialties Co, 15201 St Clair Ave, Cleveland 10, Ohio

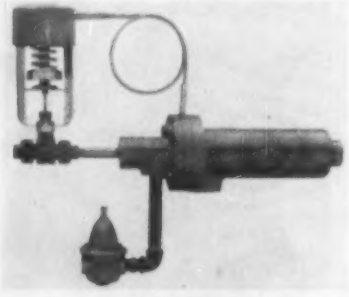


Clean steam separator

324 • Non-pressure type all-steel welded vessel provides quiet method for separating flash from water and sludge. Blow-down enters tangentially at top periphery. An internal spiral baffle, extending into drain, assists swirling action. Solids fly outward and down—only clean flash is vented to steam line. Taper design aids separation while keeping water-sludge "momentum pressure" on drain. Unit serves one or more boilers. Details on request.

Pennsylvania Separator Company, Box 348-1, Brookville, Pa.

For more data on these items, use post cards p 175. Identify your request with item number.



Steam and water mixer

326 • Mixer may be used wherever hot water is required and where steam and water are available. Unit utilizes full heat energy by injecting steam directly into the water. Mixing chamber is designed to pre-

Mead-Morrison

means **modern** *material handling*

When you buy a Mead-Morrison Tower, you can be sure of MODERN design to meet today's demands for effective design and efficient operation. Note these Mead-Morrison characteristics:

Sturdy Construction . . . demonstrated by the many installations that are giving trouble-free service year after year,

Speedy Unloading . . . exceeding the specified hourly rate in many cases,

Simple Operation . . . all grab movements controlled by only 2 conveniently arranged latched levers,

Smooth Control . . . new standards of ease and smoothness in both free digging and clean-up,

Specially Engineered for Each Installation . . . by a long experienced organization backed by complete manufacturing experience.

Mead-Morrison engineers will be glad to help you plan your new unloading facilities or give advice on increasing the capacity of your present equipment.

Mead-Morrison Rope Trolley Stationary Coal Barge Unloading Tower recently installed at the Meramec, St. Louis, Plant of the Union Electric Company of Missouri. The tower has a capacity of 600 tons per hour (throughout a barge), and is equipped with a 7-ton Mead-Morrison Grab Bucket. The plant also has a Mead-Morrison Barge Haul System which works in conjunction with the tower.

MEAD-MORRISON

Division of McKIERNAN-TERRY CORPORATION

Builders of Coal and Ore Towers and Bridges, Grab Buckets, Pile Hammers, and Special Machinery

HARRISON, NEW JERSEY

Replacement
Tubes
for any boiler

for
BIGELOW ★
BADENHAUSEN ★
CASEY HEDGES ★
CONNELLY ★
COMBUSTION ★
COLLINS ★
EDGEMOOR ★
ERIE CITY ★
HEINE ★
FOSTER WHEELER ★
KIDWELL ★
KEELER ★
LADD ★
MAXIM ★
ROSS ★
RUST ★
SPRINGFIELD ★
STIRLING ★
TITUSVILLE ★
UNION IRON WORKS ★
VOGT ★
WICKS ★
and others

No matter what your need, B.T.A. carries the most complete stocks of boiler tube sizes and gauges . . . for any make of boiler.
No need for you to stock . . . you can have spares when you need them . . . fast! 'Phone or wire!

Specialty Bending for any need

BOILER TUBE CO. OF AMERICA
McKEES ROCKS, (PITTSBURGH DISTRICT) Federal 1-7750

Philadelphia
Raphael Paul 328 Lafayette Bldg. Lombard 3-7700
Tampa
John D. Homan, 14 South Orleans Ave • Tampa 8-3952
Los Angeles
Fred S. Renauld & Co., 1014 W. Eighty-Fourth St. • Pleasant 2-6181

1

More EQUIPMENT NEWS

Begins on page 166

vent stratification and false temperature indications. According to manufacturer, inherent noise accompanying direct injection of live steam into water is held to acceptable level by infinitely variable orifice feature of steam injection nozzle.

Safety feature on control will shut down mixer in event of failure of water supply. Operation is automatically resumed when interference is corrected.

Fulton Sylphon div, Robertshaw-Fulton Controls Company, Box 400, Knoxville, Tennessee

Distribution panelboards

327 • Factory-assembled plug-in fusible panelboards are available with 200 through 1200 amp mains. Outstanding advantage, according to manufacturer, is its availability. Standardized plug-in components can be stocked for immediate delivery on any job requirement. These components include both main and branch circuits as large as 200 amp, either 250 or 600 v.

All units are dual horsepower rated for standard and time delay fuses. Safety interlock in cover prevents unauthorized personnel from opening unit while power is on. Request bulletin SD-29 for details.

Square D Co, 6060 Rivard St, Detroit 11, Michigan

For more data on these items, use post cards p 175. Identify your request with item number.

Window-type annunciator

351 • *Electro-Pane* unit produces a sequence of four different indications by use of three hermetically sealed mercury switches. No small relay-type contacts or coils are used, nor is any auxiliary equipment required. Switching is accomplished by two solenoids and standard lamps are used for illumination. Indications are shown by different colors on the nameplate.

Electro Devices Incorporated, 4025 Easton Ave, St Louis 13, Mo.

Cleaner for electric parts

352 • *Dynasol* is a chlorinated aliphatic hydrocarbon used for cleaning windings, motors, meters, circuit breakers, cables, electronic parts, and transformer insulators.

(*Continued on page* 196)

Multiply This Monobed Resin by 30,000

Water conditioning engineering firms are being continuously called upon to supply systems capable of delivering boiler feedwater from which virtually all dissolved salts have been removed. Where the ultimate in ion-free water is demanded, those water conditioning experts are now recommending AMBERLITE MONOBED® exchange resins.

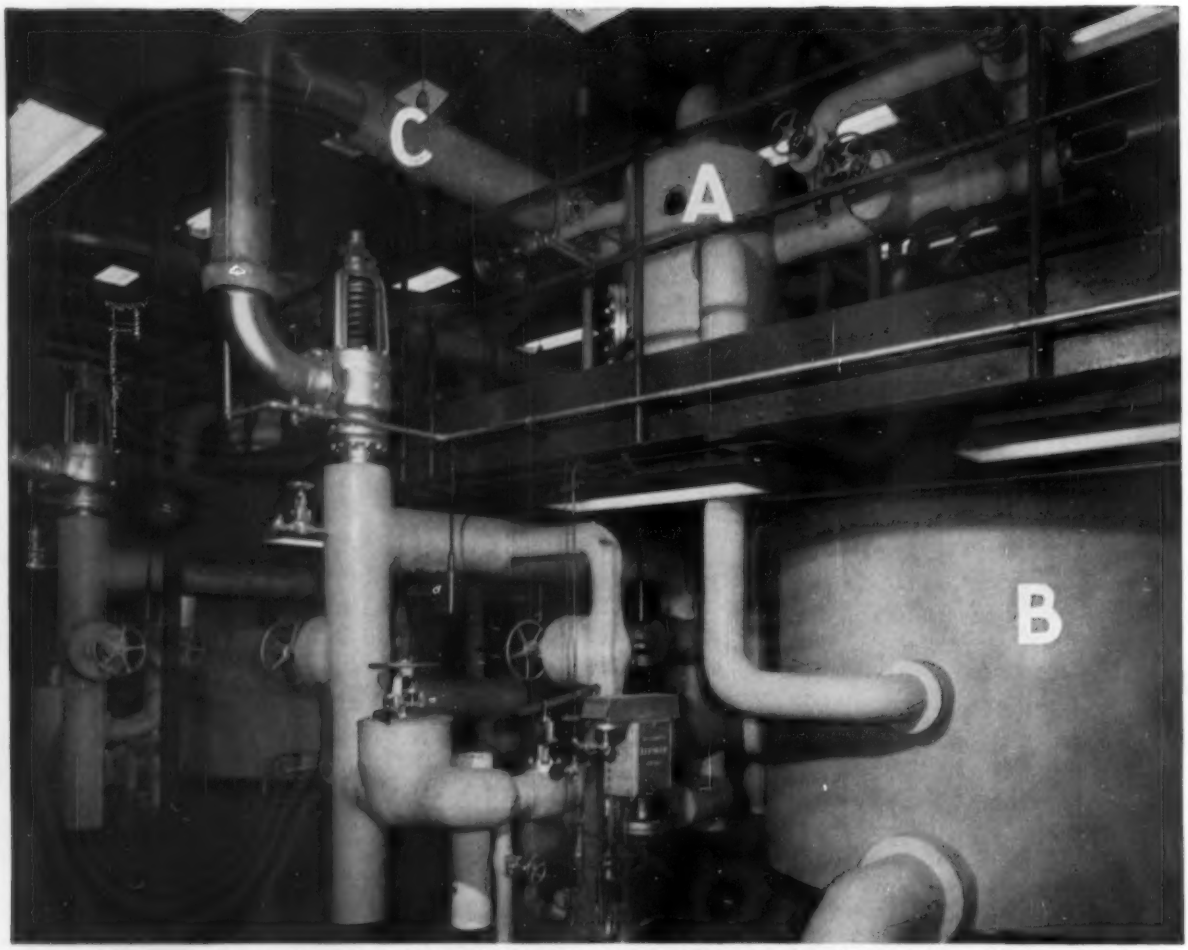
From laboratory research columns like the one above, and from long experience in the field, Rohm & Haas Company has developed ion exchange resins used in industrial deionization systems 30,000 times as large as the one pictured here. One such system is capable of treating 5000 gallons of water per minute continuously, producing an effluent of a quality comparable to that obtainable in the laboratory.

Engineering firms are recommending more than just AMBERLITE MONOBED resins, however. Wherever water must be softened, dealkalized . . . wherever dissolved salts must be removed or replaced, there's a place for the AMBERLITE ion exchange resins.

Ask for "If You Use Water . . . ," a 24-page booklet of basic information on the ion exchange treatment of water.

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION, PHILADELPHIA 5, PENNSYLVANIA



Piping and equipment in the Sunbury Steam Electric Station of the Pennsylvania Power & Light Company, insulated with "Featherweight" 85% Magnesia Insulation. The flash tank, "A", and the deaerator, "B", which operate between 250 and 275°F, are insulated with 2 inches of 85% Magnesia and ½ inch of asbestos cement. The piping, indicated at "C", is insulated for the protection of personnel.

K&M "FEATHERWEIGHT" 85% MAGNESIA INSULATION KEEPS OPERATING COSTS DOWN

Plants of almost every type throughout the country have benefited from the use of K&M "Featherweight" 85% Magnesia Insulation. By reducing heat losses, operating efficiency is improved and costs are kept down. Made of 85% basic carbonate of magnesia and asbestos fiber, "Featherweight" effectively insulates piping and equipment with temperatures up to 600°F.

Used with a primary layer of K&M Hy-Temp Insulation (Diatomaceous Silica), the combination is effective up to 1900°F. The application of these two layers—with staggered joints—eliminates the heat loss that normally occurs when expansion causes the joints to open in single layer installations.

Also available is "Featherweight" Water-Resistant Magnesia Insulation for temperatures up to 450°F. It is used underground where severe water exposure may damage the insulation or on indoor steam heated lines and equipment where high humidity and moisture are present.

If your company has an insulating problem, contact your K&M distributor who is an experienced applicator. Or write directly to us.

KEASBEY & MATTISON COMPANY • AMBLER • PENNSYLVANIA

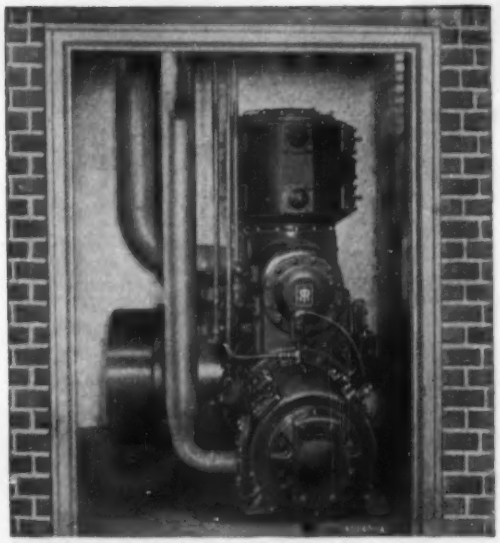
Nature made asbestos . . . Keasbey & Mattison has made it serve mankind since 1873

IN CANADA: ATLAS ASBESTOS COMPANY, LTD., MONTREAL, TORONTO, WINNIPEG, VANCOUVER

K&M Asbestos ®

MORE AIR POWER in less floor space

That's one of the many advantages offered by this space-saving **XLE** *compressor:*



A bronze company squeezed this XLE into a small, unused storage room.

Packaged design for minimum floor space, and specially balanced for minimum foundation... ideal for skid-mounting.

Easy to operate... push button starting, grouped controls, automatic force-feed lubrication, automatic condensate removal, automatic air-operated starting unloaders and capacity control.

Easy to install or relocate... ready-to-run, assembled shipment ... simplified air and water piping.

Easy to maintain... simplified long-life construction... full-floating, cool-running, aluminum-alloy bearings that require no adjustment... no need to open the sealed crankcase which stays clean inside... streamlined exterior also easy to keep clean.

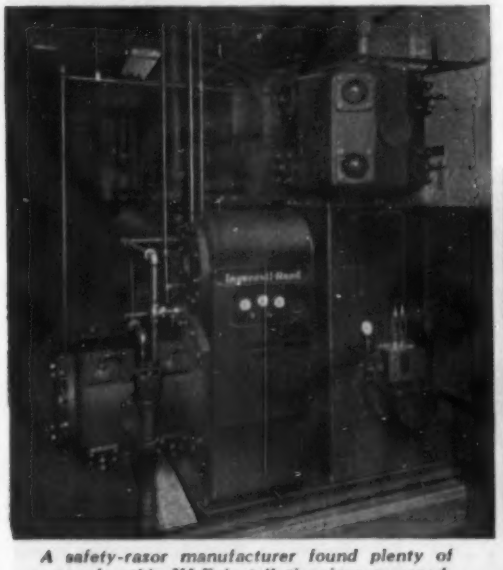
Low operating costs... new high-efficiency, long-life I-R Type A Channel Valves result in compressor efficiency comparable to the largest units... durable, high-efficiency tube-and-fin intercooler saves water... efficient direct-connected motor.

Built for reliable, continuous full-load service... sizes 125, 150, 200, 250, 300, 350 horsepower... discharge pressures 80 to 125-psi, two stage... write for more information today.

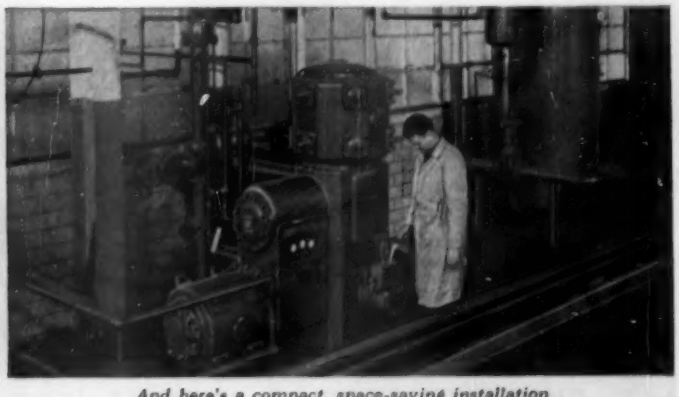
Ingersoll-Rand

I-105 11 Broadway, New York 4, N. Y.

COMPRESSORS • AIR TOOLS • ROCK DRILLS
TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS
DIESEL AND GAS ENGINES



A safety-razor manufacturer found plenty of space for this XLE installation in a screened-off basement corner.



And here's a compact, space-saving installation of an XLE compressor, aftercooler and air receiver in a tool plant.

NEW PACKING DEVELOPED BY CHESTERTON FOR

sulphuric acid

Sulphuric Acid, Nitric, Hydrocloric, in fact on any Acid* Blu-Lon, Chesterton Style 320, makes a tight lasting seal. Blu-Lon is braided from chemically pure African Blue Asbestos and through a specially designed method each single strand is immunized and lubricated with DuPont Teflon. This process is not to be confused with other quick dip Teflon treatments as Blu-Lon is a thoroughly impregnated Teflon packing. This added protection plus Blu-Lon's unique breaking-in lubrication places this packing in an Acid resisting field by itself.

Chesterton Blu-Lon is recommended for strong acids of 1–4 pH value. Note chart below which recommends three Chesterton Packings for full range of chemicals 1–14 pH.

Blu-Lon comes thoroughly lubricated, *ungraphited*, blue in color. It is ideally suited for service on chrome plated or stainless steel shafts.

* *For Hydrofluoric Acid write us for special recommendation.*

A pH SCALE FOR CHEMICAL PACKINGS

1 TO 4	5 TO 10	11 TO 14
pH VALUES	pH VALUES	pH VALUES
STRONG ACIDS	WEAK ACIDS OR ALKALIES	STRONG ALKALIES
#320	#315	#322
Blu-Lon	Carsons	White-Lon

PACKING Chesterton SERVICE

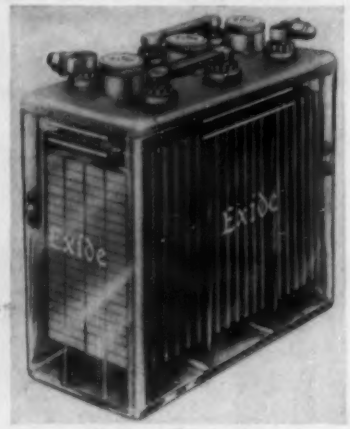
A. W. CHESTERTON CO. • EVERETT 49, MASS.
America's Oldest Manufacturer of Mechanical Packings

More EQUIPMENT NEWS

Begins on page 166

It is one-twentieth as toxic as carbon tetrachloride, evaporates at the same rate, is nonflammable, and leaves no residue. *Dynasol* is a single basic material and contains no petroleum solvents, penetrants or spreader.

Chemical Cleaning Service, Inc,
Box 388, Jackson Heights 72, N. Y.



Storage batteries

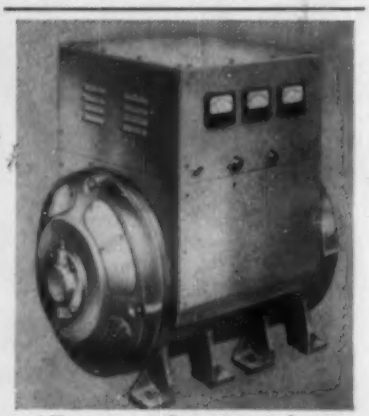
328 • These batteries, designed specifically for emergency lighting, are first of their type to gain UL approval. According to manufacturer, 8 to 12 yrs of useful life is anticipated for the units.

Polystyrene, a clear, heat-resistant plastic is used for container and cover. The material is said to have extremely high impact resistance and mechanical strength in addition to its chemical and physical stability.

State of charge is indicated by colored pilot balls floating in a vertical channel molded into corner of container. According to company, pilot balls may be observed from distances to 30 ft. Further information in form 5370, available on request.

Exide Industrial division,
Electric Storage Battery Co,
Box 8109, Philadelphia 1, Pa.

For more data on these items, use post cards p 175. Identify your request with item number.



All-static voltage regulator

329 • Unit is designed to provide voltage regulation for 400-cycle generating equipment under all load conditions. Usable for direct excitation of ac machines, unit elim-

Walnut cracks tough problem in lubrication —chooses STANDARD HD OIL

William G. Eslick, Plant Superintendent, goes over lubrication and overhaul records with Standard Oil lubrication specialist Albert J. Thomas. Working with customers to help crack tough lubrication problems is Al Thomas' business. Al has the training and experience for such jobs. A graduate of Iowa State College with a B.S. in Mechanical Engineering, Al joined Standard Oil in 1950. After completing Standard's Sales Engineering School, he began working with industrial accounts on their lubrication problems. Customers of Al's find his experience and training pay off *for them*.

THERE WAS LUBRICATION TROUBLE in the power plant at Walnut, Iowa. The three diesel engines in the plant were experiencing stuck rings, excessive crankcase deposits and hard carbon deposits. Engines were sluggish and would not produce full power.

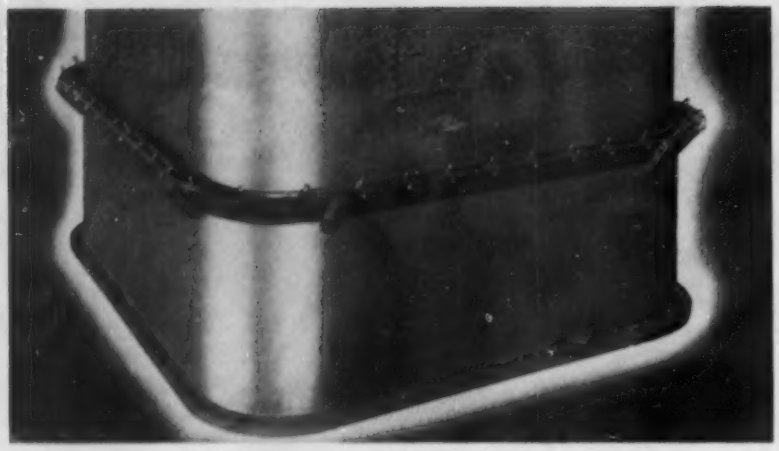
William G. Eslick, Plant Superintendent, working with Standard lubrication specialist, A. J. Thomas, decided on a course of action: he switched the engines to STANDARD HD Oil. Now, after more than 26,000 hours of operation, engines are clean. Ring sticking is eliminated, wear reduced to a minimum. Carbon deposits are reduced and remaining carbon is easily scavenged because it is now soft and flaky, not hard as before.

The initial fills of STANDARD HD Oil—plus make-up—are still in the engines. The community of Walnut, Iowa, is getting first rate electric service. Its power plant's lubrication problems have been licked. STANDARD HD Oil has again demonstrated its superior lubricating characteristics.

Perhaps you would like to know more about STANDARD HD Oil. In the Midwest a call to your nearby Standard Oil lubrication specialist will bring a prompt response. Or contact, Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (Indiana)

STANDARD

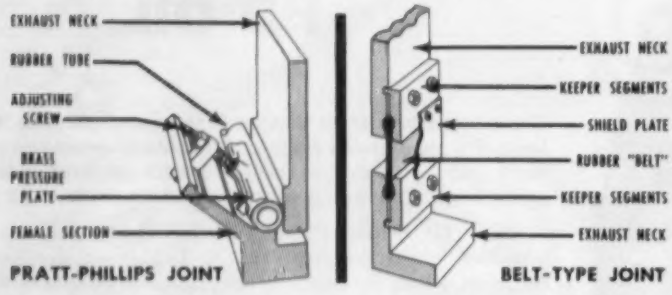


simple-flexible

TURBINE-CONDENSER EXPANSION-JOINTS

Pratt-Phillips joint is ideal flexible connection. Absolutely air-tight under vacuum and steam-tight under exhaust conditions, it is easily installed and sets up no undue strains in the turbine casing.

Rubber element provides flexibility in all directions. The rubber sealing member is held under compression by pressure plates. Protected from oil and sunlight, it lasts for many years. The exclusive Pratt-Phillips design exposes only one-twelfth of the rubber surface to steam.



Easy to install or replace. The rubber element can be installed, removed or replaced in less than three hours on even the largest joints. No special rubber shapes are required; the same type is used on round or rectangular stacks.

Other types of joints available. For installations where space is limited, the belt-type expansion joint is advantageous since it requires no more space than the exhaust stack itself.

The Henry Pratt Company offers complete engineering and manufacturing facilities for exhaust stacks and joints, flues, ducts, butterfly valves and other power plant equipment.

Our engineers can help with your problems...write for full details.

HENRY PRATT

POWER INDUSTRY EQUIPMENT

TURBINE-CONDENSER

Expansion Joints

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill.

More EQUIPMENT NEWS

Begins on page 166

inates need for rotating dc exciter. This is claimed to result in faster response time, closer regulation, and does away with all wearing or moving parts. Voltage is regulated to ±.5%. Units may be installed for parallel operation. Request bulletin T-8400 for details.

Inet div, Leach Corp, 4441 Santa Fe Ave, Los Angeles 54, Calif.

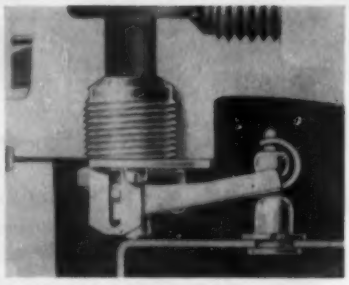
Deaerating heaters

338 • Unit is said to be capable of reducing oxygen content in boiler feedwater down to .03 cc per liter. It may be used with boiler capacities of 1000 to 30,000 lbs per hr, and will operate at steam pressures (at the regulator) of 7 to 250 psi.

Unit operates fully vented at only atmospheric pressure. Vent condenser is of the direct-spray contact type. Design features "floating" temperature control at 211 F through one or more internal steam distributing tubes. Control by means of combination temperature and pressure regulator is responsive to ¼ F. Request bulletin 1300 for further information.

Fred H Schaub Engineering Co, 2110 South Marshall Boulevard, Chicago 23, Illinois

For more data on these items, use post cards p 175. Identify your request with item number.

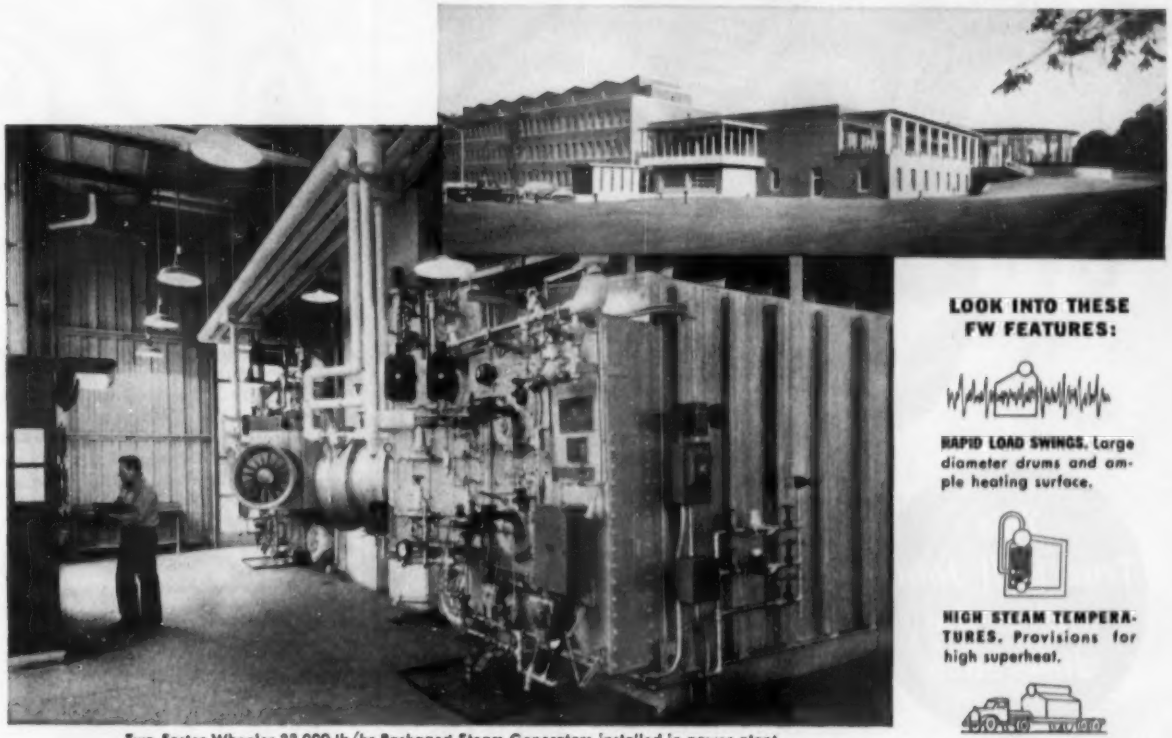


High-efficiency steam traps

333 • Low, medium and high pressure steam traps are available in semi-steel, cast steel and forged steel construction. They may be used on all pressures to 2500 psi and temperatures to 1100 F.

Manufacturer reports plant surveys indicate that under normal operating conditions many of these units are operating at less than 1% of their rated capacity. All internal working parts are of heavy stainless steel. Design feature is dual fulcrum that

two FW packaged steam generators add up to LOW POWER-PLANT COSTS at new IBM laboratory



Two Foster Wheeler 22,000 lb/hr Packaged Steam Generators installed in power plant of new IBM research laboratory at Poughkeepsie, N. Y.

International Business Machines Corporation's new research laboratory at Poughkeepsie, N. Y. is designed for maximum efficiency and dependability of all building services. For low power-plant costs two Foster Wheeler packaged steam generators were chosen.

On actual test, each of these new boilers has produced in excess of the guaranteed capacity of 22,000 lb of steam per hour at 125 psig operating pressure. They will supply the heating load for the entire building, as well as power for the steam-turbine-driven refrigeration plant.

Compared to conventional boiler construction, these standard-design, plant-assembled water tube steam generators effect substantial savings in power plant costs. The high efficiency and easy accessibility of the Foster Wheeler design contribute to low operating and maintenance costs, thus, as in this installation, justifying the use of multiple units.

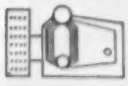
Foster Wheeler Packaged Steam Generators are available in capacities up to 45,000 lb of steam per hour; final steam temperatures to 825 F; pressures to 900 psig. For complete information, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

LOOK INTO THESE FW FEATURES:

RAPID LOAD SWINGS. Large diameter drums and ample heating surface.

HIGH STEAM TEMPERATURES. Provisions for high superheat.

ADAPTABILITY. Easily moved. Require only a slab foundation — permit outdoor installation.



ECONOMIZERS. Package economizers available to increase capacity and minimize fuel cost.

ACCESSIBILITY. For inspection, cleaning and maintenance.

CLEAN HEATING SURFACES. Soot blowers incorporated . . . cleaning without boiler shutdown.

FOSTER WHEELER

INDIVIDUALLY
Vacuum-Tested
to prevent leaks!

This True Ball Joint makes the difference

You win several ways with Dart Unions. They're drop-tight. They can be used over and over. They're easy to install. You're ahead because you save (1) the cost of a replacement union, (2) the expense of removing an inferior union and installing a new one, and (3) possible damage to property and materials. Insist on Darts.

QUICK FACTS

- Leakproof because precision-machined to a true ball joint and spherically ground
- Extra wide seats of bronze alloy resist pitting and corrosion
- Heavy shoulders (take severe wrenching without damage)
- Nut and body practically indestructible (of air refined, high test malleable iron)
- Each Dart is individually vacuum-tested — absolutely tight when it leaves the factory

DART

UNIONS

DART UNION COMPANY • PROVIDENCE 5, RHODE ISLAND

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CALL YOUR LOCAL DISTRIBUTOR FOR PROMPT DELIVERY OF DART UNIONS

More EQUIPMENT NEWS

Begins on page 166

powers valve lever. This includes a primary high leverage fulcrum to open valve and give maximum unrestricted flow.

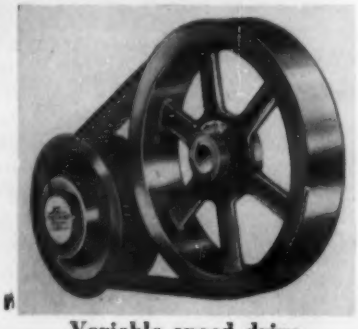
Strong, Carlisle & Hammond Co, 1392 W 3rd St, Cleveland, Ohio

All-purpose arc welder

337 • Combination arc welder provides a choice of either ac or dc welding current. It is said to provide ideal welding arc for every type of manual welding job. For ac welding, machine provides a single-phase transformer type welder. For dc welding, current is supplied through heavy-duty rectifiers. Both voltage and amperage are controlled to give desired control of arc characteristics. Arc booster switch permits selection of normal or "hot" starting.

Current models available are 300, 400 and 500 amps ac combined with dc capacities in 200, 300, 375 and 450 amps. Further information on request to manufacturer.

The Lincoln Electric Co, 22801 St Clair Ave, Cleveland 17, Ohio

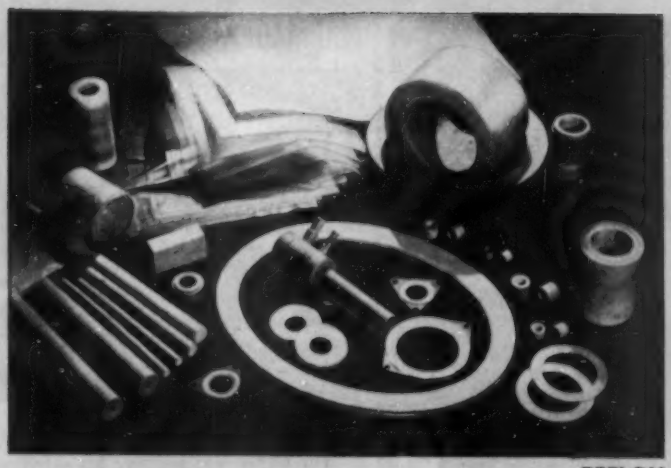


Variable speed drive

331 • Unit is designed to give infinitely variable speed with 2:1 ratio for 1 to 5-hp drives. Simplified design, according to manufacturer, provides positive clamping of two adjustable flanges eliminating fretting corrosion. Pitch diameter is changed by single adjustment screw that moves both flanges simultaneously. Further information in bulletin 497, obtainable on request.

T B Wood's Sons Company, Chambersburg, Pennsylvania

For more data on these items, use post cards p 175. Identify your request with item number.



TEFLON

PUMP VALVES

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SOFT BRAIDED ASBESTOS PACKING

Fibrous and Metallic Packing For Every Industrial Purpose

The line of Anchor packings in 1955 is greater than ever! Over 300 various types of packings are today offered you by Anchor, for every industrial purpose.

For complete information on our packings, we invite you to write us today. We feel they offer many distinct advantages and savings.

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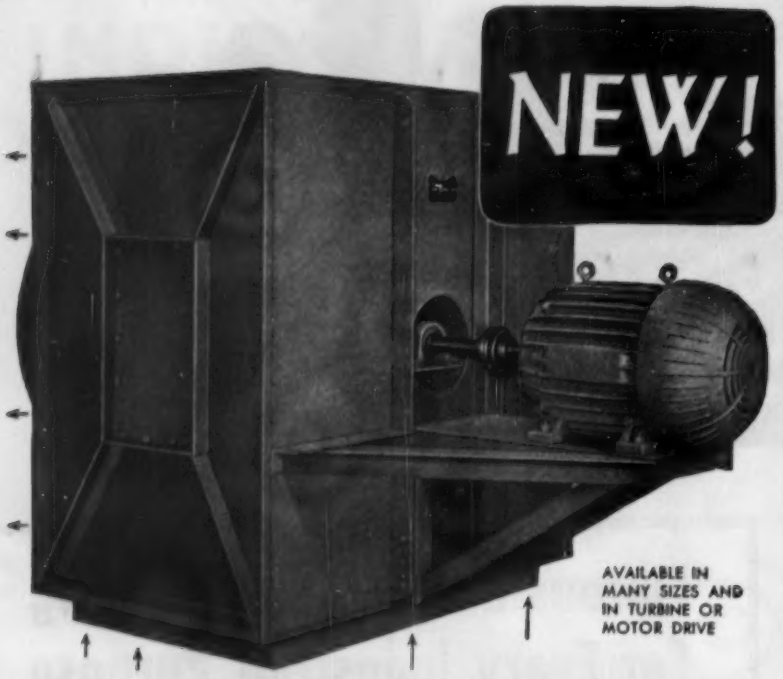


WING PACKAGE DRAFT INDUCER

FOR POWER PLANTS

MOTOR AND FAN DESIGNED AS ONE COMPLETE REMOVABLE UNIT

MAKES INSTALLATION EASIER

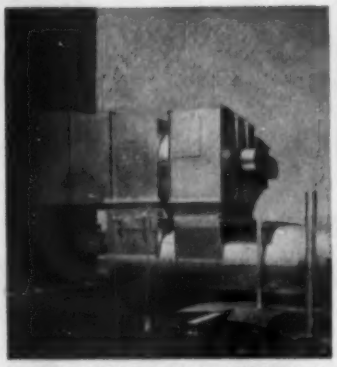
FACILITATES INSPECTION AND MAINTENANCE

SAVES SPACE

ELIMINATES WATER COOLING OF BEARINGS

INTERCHANGEABLE INLETS—TOP, BOTTOM OR SIDES

NO LUBRICATION REQUIRED—BEARINGS PRE-SEALED



WING PACKAGE DRAFT INDUCER AT PLANT OF WELCH GRAPE JUICE CO.

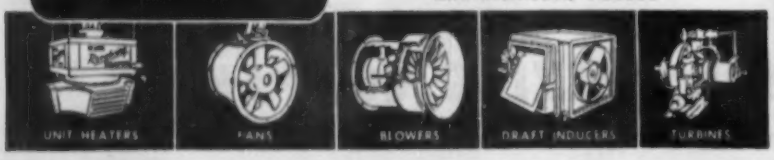
Write for complete details

Wing

L. J. Wing Mfg. Co.

50 Vreeland Mills Road
Linden, New Jersey

Factories: Linden, N. J. and Montreal, Canada



MARMADUKE

Continued from page 154

"I pulled up to the plant that afternoon and found a red-hot reception committee of the owner and plant manager waiting for me. They were both about to flip their lid and I could tell they were waiting to tear into me. I barged past them and went for the boiler—it was in one corner of the plant and seemed as shipshape as the day it was installed.

"A look inside told another story. The corrugated furnace had a bag hanging down like a cow's udder, only it was about twice the size.

"The owner was popping his safeties about 'these automatic boilers that are supposed to be foolproof—and look what happens.' I could see the plant manager didn't know any more about boilers than the owner did, so I ignored them both.

"First thing that looked fishy was the condensate-return tank. It had been installed on the floor in back of the boiler, but it wasn't there. Instead, it was about six feet above the boiler—on wooden stilts.

"'What's the return tank doing up there?' I asked the big boss. 'You going to blast her off to the moon?'

"'Hell, no,' explained the plant manager, 'the feed pump kept getting vaporbound, so I figured if I raised the tank, the pump would have a positive head of water and stop our trouble. After I raised it our trouble did stop.

"'Sure,' I answered, 'but three months ago our other inspector told you your pump was vaporbound because your steam traps out in the plant were blowing steam. According to his report, he asked you to find those leaky traps and repair them.'

"Just then I noticed a globe valve on the suction side of the feed pump, between the pump and the condensate-return tank. I knew that valve had not been installed originally. I tried it and found it closed.

"'What's this valve doing here and why is it closed?' I asked the manager. He looked at the valve with a dumb look on his face and said he didn't know. So he called in the janitor, who also doubled as the boiler operator. That character looked more fogbound than the plant manager. The janitor explained that after the tank was raised, it drained water into the boiler during the night while the boiler was shut down and the steam pressure dropped. So he had a brain storm and solved that little problem by installing the valve. Said he always closed it before leaving the plant at night. That gave me a clue.

"'If you always close that valve at night, did you forget to open it this

Permutit installs world's largest double-unit Deaerating Heater

THE first of these two units was installed in 1939. Why did this famous oil refinery *again* specify Permutit when they expanded in 1952?

Because the first unit gave 13 years of *better-than-guaranteed* performance . . . often at 115% of rated capacity. Seventeen field performance tests showed oxygen reduced to 0.0 ml/l., free CO_2 to *zero!*

These Permutit twins now heat and deaerate makeup at the rate of 3,000,000 lb./hr.! By *completely* removing oxygen and free CO_2, they prevent corrosion . . . help avoid costly shutdowns and replacements of tubes, piping, pumps, valves.

For data to help you select your next deaerating heater, write for Bulletin No. 2357. The Permutit Company, Dept. P-3, 330 West 42nd St., New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance St., Montreal.

WATER CONDITIONING HEADQUARTERS FOR OVER 40 YEARS

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CONSECO SERVICE is as near as your telephone. Simply call Maintenance Department.

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Designers and Builders of Equipment for Power, Refining, Chemical and Marine Industries

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Equipment Designed and Built by CONSECO

Conseco and its subsidiaries design, build, and install power and processing equipment and accessories, some of which are listed here. Purchasers of Conseco equipment benefit from our maintenance division's quarter century experience in rebuilding, modernizing, and maintaining our own as well as competitors' equipment. This coordination assures easy accessibility for maintenance and low operating cost. Send for bulletins covering equipment in which you are interested.

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STEAM GENERATORS
PRESSURE VESSELS
CENTRIFUGES
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PUMPS, INSTRUMENTS, SPECIALTIES

MARMADUKE

Continued from page 202

morning when the boiler failed?' I asked.

"My question took him by surprise. After sputtering and shaking his head, he finally admitted that he must'a forgotten to open it.

" 'That's got nothing to do with anything,' piped up the owner in defense of his man. 'This boiler is supposed to have a low-water alarm and she had no business failing even if that valve was closed.'

" 'How about that?' I asked the janitor. 'Did the low-water alarm go off when you started up this morning with the feed-line valve closed?'

" 'Sure she went off—and how,' he answered, his face lighting up. 'But we had to start the plant and I found by holding my finger on the low-water cutoff reset button, the bell stopped ringing and the boiler started OK!'

" 'You mean you didn't try to find out what was wrong when that alarm went off?' I asked, not believing my ears and getting up a little steam myself.

" 'Look here,' cut in the owner. 'Why this third degree? This is our rush season and I didn't invest all this money to get a foolproof boiler that won't work when I need it. I told Judson here to start that boiler working any way he could and that's exactly what he did.'

" 'What I can't understand,' I finally said, trying to keep from blowing my safeties, 'is how you had time to stand here and hold this button.'

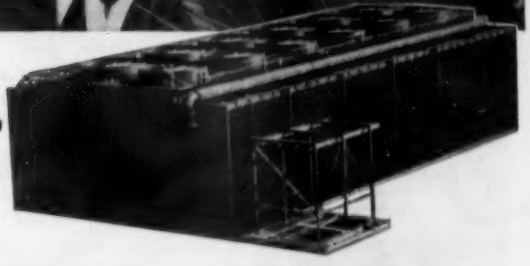
" 'I wasn't born yesterday,' grinned the janitor, with a smile lighting up his map again. 'That bell was driving me nuts every time I let go the button, so I used my head. I removed the cover of the relay box and jammed a pencil into the low-water cutoff switch to keep it closed. That worked OK. But when I came around a half hour later I saw there was no water in the gage glass. That's when I looked into the furnace and saw the bag.'

"That story sounded too screwy for a grown man to tell. So I yanked the cover off the relay box. Sure enough, there was the pencil, still holding the switch closed. Of all the brainless stunts, that was the worst I ever saw and I've been around power plants—boy and man—since 1890.

"I never argue with a jackass, so I got busy on the phone and got hold of the boiler manufacturer's nearest warehouse up in Atlanta, about 125 miles away. They promised to put a new furnace on a truck and have it at the plant next morning. Then after phoning around for a few hours I finally got hold of a certified welder.

"Next morning we burned out the

He tests his purchases...



Do you?

Cooling tower owners, too, turn up some surprising test results — as you will discover when you follow the simplified testing procedure described in a new Marley technical publication, "Test Your Tower".

You may be astounded, for example, with the difference between your tower's actual performance and the performance "guaranteed" by the manufacturer. Or, if you have a tower that was purchased with plant expansion in mind, a test now may reveal that the future performance you are counting on is purely theoretical — that it won't be there when you need it.

But whatever your situation, it will pay you to test. And "Test Your Tower" makes testing simpler, more direct, and more accurate than ever before. Get your free copy right away — by mailing the coupon below or calling the Marley representative in any of fifty major cities.

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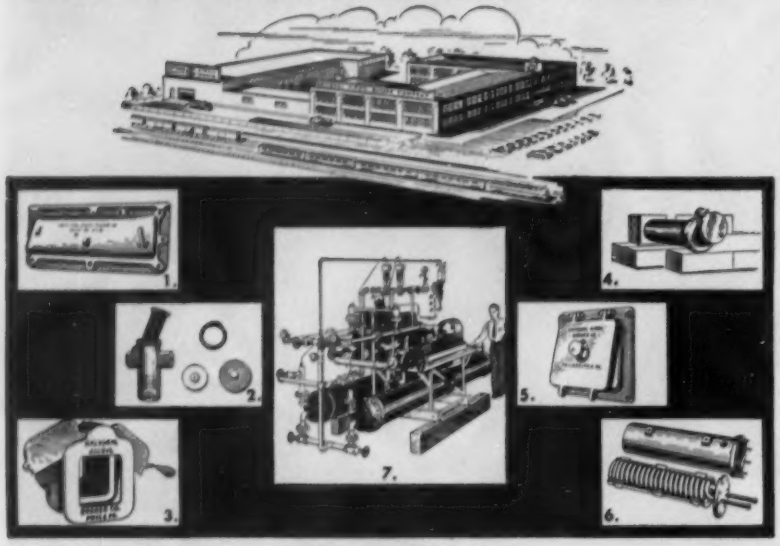
A Complete Line of
COMBUSTION ACCESSORIES



for EVERY
INDUSTRIAL LIQUID FUEL-GAS INSTALLATION

1. Air Control Door and Frame, top hinged, ratchet type, heavy duty, for manual control. Surfaces are machined to a close fit.
2. Fuel Oil Suction Strainer, single type. Large basket area insures low pressure drop; cover and basket easily removed for cleaning.
3. Wide-View Peephole, safety, curtain type. Cobalt glass removed to show bearing surface for curtain. Curtain halves are interlocked—open simultaneously.
4. Ignition Port with Refractory Tile No. M896 . . . for use with standard 3" pipe. Also serves as a peephole.
5. Furnace Relief and Access Door, heavy construction, practically air tight. Door casting correctly weighted, lined with plastic refractory retained by imbedded grill; with observation port and cover.
6. Fuel Oil Heater, Self-Cleaning, Spiral Coil type. High oil velocity in coil, resultant turbulence prevents carbon formation. No internal connections or joints.
7. Fuel Oil Pumping and Heating Unit . . . Twin or Single Pumps, Steam driven, Electric driven or combination Steam-Electric, with Single or Double Fuel Oil Heaters and accessories for feeding oil at constant pressure and temperature.

. . . yes, just as we are proud of supplying the *right* liquid fuel or gas burning equipment (over 45 years experience throughout industry), so, also, are we proud of our full line of highest quality accessories to supplement your every combustion need. Within our modern, "daylight" factory, salesrooms and general offices NATIONAL AIROIL likes and adheres to the phrase, "nothing but the best"! We believe that our record speaks for itself . . . i.e.; the "right combination" for you in achieving maximum combustion economy is: NATIONAL AIROIL Fuel Oil, Gas or Combination Oil and Gas Burning Equipment; NATIONAL AIROIL Combustion Accessories; and, NATIONAL AIROIL Engineering Consultation.

May we be of help to you in accomplishing your particular installation or in solving that difficult problem?

Ask for Brochure No. 10

NATIONAL AIROIL BURNER CO., INC.

1250 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.

Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

MARMADUKE

Continued from page 204

damaged furnace and put in the new one. We also burned out most of the tubes and replaced them. That job took 30 hours, working round the clock. And my firm shelled out $2000 in repairs alone. I don't know what the outage cost came to—but it was plenty.

"After steaming her up, I went out into the plant and found four steam traps blowing steam. After I showed the plant manager how to repair them, I had that condensate tank put back on the floor where it belonged. Then I had the suction valve removed from the feed line. After that job was done, I told the owner I would recommend our firm canceling his insurance. That's when he blew a gasket and stripped a few gears for good measure. He raved about boiler inspectors being as crazy as boiler manufacturers.

"Later, I learned that the last time someone tried to get an operating engineer's license law passed in Georgia, that plant owner squawked the loudest. He claimed that since boilers were made with all the safety devices, anyway, why have regular operators, licensed or not licensed, to watch the boiler?

"After that experience, I quit being a boiler inspector in Georgia. Straightening out accidents that just naturally happen at times never bothers me, whether an act of God—or what. But there's no sense dealing with plant owners who go out of their way to look for trouble.

"And don't forget this," wound up Marmy, bouncing the bar with another haymaker, "there's no such thing as a foolproof device—not when it's placed in the hands of fools."—*SME*

NOTE: *This story may sound funny, but results could have been tragic because it actually did happen.*

Marmy's Mailbox

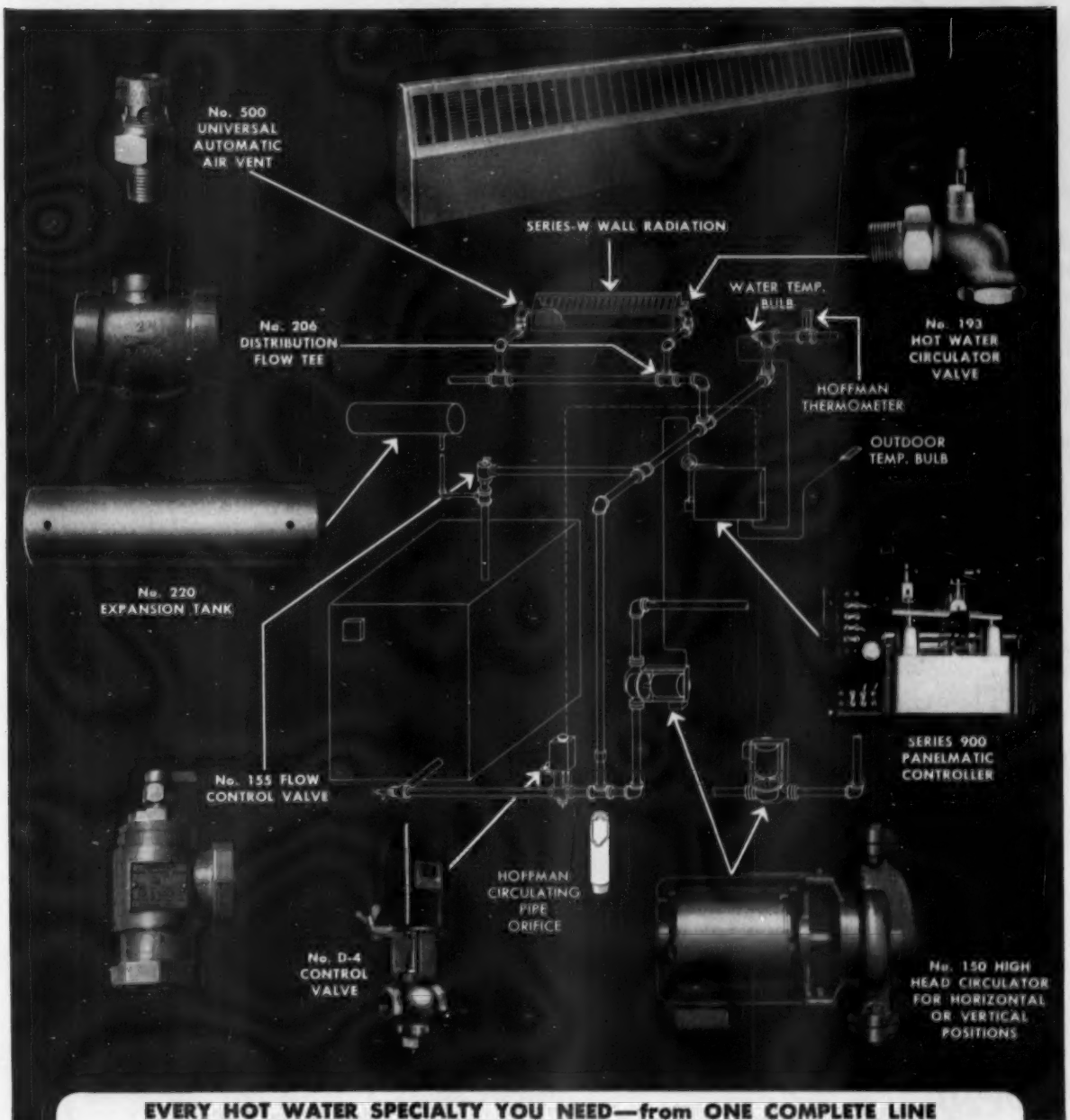
Just finished reading "Marmy Murders Science" in the June issue and he almost murdered me with laughter. An excellent story. This one should be included in Volume II of *The Marmaduke Story* when it comes out.

E SPASEK *San Francisco, Calif.*

The latest of the Marmaduke stories is very good. They're really something—a new technique in trade-paper editing. I took a poll around here and find everyone who gets POWER in this agency reads Marmaduke with much interest. There are five members of our staff who have the magazine routed to them regularly—and all five like the series. That, I should say, is 100% batting average—darn good.

W W NAGLE *Reading, Pa.*

HOFFMAN COMPLETE EQUIPMENT
FOR HOT WATER HEATING SYSTEMS


No. 500 UNIVERSAL AUTOMATIC AIR VENT
SERIES-W WALL RADIATION
WATER TEMP. BULB
No. 206 DISTRIBUTION FLOW TEE
No. 193 HOT WATER CIRCULATOR VALVE
HOFFMAN THERMOMETER
OUTDOOR TEMP. BULB
No. 220 EXPANSION TANK
SERIES 900 PANELMATIC CONTROLLER
No. 155 FLOW CONTROL VALVE
HOFFMAN CIRCULATING PIPE ORIFICE
No. D-4 CONTROL VALVE
No. 150 HIGH HEAD CIRCULATOR FOR HORIZONTAL OR VERTICAL POSITIONS

EVERY HOT WATER SPECIALTY YOU NEED—from ONE COMPLETE LINE

Now you can specify Hoffman products for every spot on a hot water heating system—with three important advantages to you. First, you are assured uniform operating efficiency; second, it saves time from buying to billing; third, it provides one uniform guarantee from a single, recognized source. And, in addition, builders are quick to appreciate the sound Hoffman design features that cost no more than ordinary kinds. New Bulletins on High Head Circulators, Flow Control Valves, Expansion Tanks, Flow Tees, Circulator Valves and Wall Radiation are available, free, no obligation.

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Makers of Valves, Traps, Hot Water Heating Systems, Vacuum and Condensation Pumps — Sold by Leading Wholesalers of Heating and Plumbing Equipment

Pay Off Plenty in

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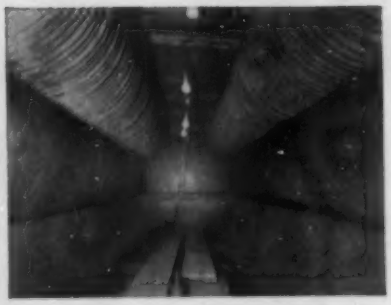
R&I, pioneer and a leading producer of castable refractories, offers MOLDIT—the most successful line of hydraulic setting, castable refractory materials for the greatest range of industrial heating applications.

With Moldit—mixed as ordinary concrete—you pour, cast or gun your own refractories in any size and shape, fast. There's no ramming or pounding. No high-cost inventory of special shapes to maintain.

MOLDIT LASTS—outlasts the rest. That's why it is constantly replacing other refractory materials. Moldit air-sets, without prefiring, to full refractory hardness. It's stronger, more resistant to thermal shock and abrasion, impervious to moisture. Plant after plant reports reductions of as much as 90% in repair and maintenance costs when Moldit Castables replace other refractories.

If you have trouble with your present refractory brick, shapes or linings, you can end it with Moldit Castables.



Ashpit of large coal-fired boiler completely "gunned" with R&I Moldit. Records show not a single repair required in 11 years of constant service in a number of ash hoppers lined with Moldit.

Gunning a 5½" thickness of Moldit Chrome Refractory on a boiler floor for maximum resistance to molten slag at 2750° to 2850° F. Such floors have been in service for 6 and 7 years without a failure.

Moldit Castable Refractories

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REFRACTORY CASTABLE AND BONDING CEMENTS • INSULATING BLOCK, BLANKETS AND CEMENTS

FOR EVERY REQUIREMENT

There are 10 Moldit Refractory and Insulating Refractory Cements to best meet specific thermal, mechanical and chemical corrosion conditions from 2000° to 3000° F.

Send for catalog on Moldit Castables. Also get the story on R&I Super #3000, the truly "wonder" refractory bonding mortar.

REFRACTORY & INSULATION CORPORATION

132 WALL STREET • NEW YORK 5, N. Y.

More PLANT PROBLEMS

Begins on page 142

Outdoor lines (*from p* 144)

4 good reasons for electrical tracing

GT will find that tracing with electric cable has these advantages: (1) No need to slope piping; pockets won't affect operation. (2) Expensive condensate-return lines are eliminated. (3) Standard-size pipe insulation can be used since heating cable is only ¼-in. OD. External steam tracers require oversize insulation. (4) Operation can be automatically controlled with thermostat at nominal cost.

Electrical power supply depends on pipe size since heat losses are proportional to pipe surface area. Wattage per foot can be controlled by varying cable length or by using several cables to get two, three or more feet of cable per foot of pipe. Manufacturer can supply details of cable characteristics, terminal connections and splices.

D W HALLMAN *Allentown, Pa.*

Steam preferred to electrical tracing here

We find steam more effective than electricity for our heavy-fuel-oil lines. Control is easier and it does not cause electrolysis as leaky spots do in heating cables when dissimilar metal contacts steel.

Our installation consists of 4-in.-dia fuel-oil lines from plant to outdoor storage tanks. External steam tracer is 2-in. dia. All piping is extra heavy and welded. Tracer is spot welded every 6 to 9 inches, giving it ample support and aiding heat transfer.

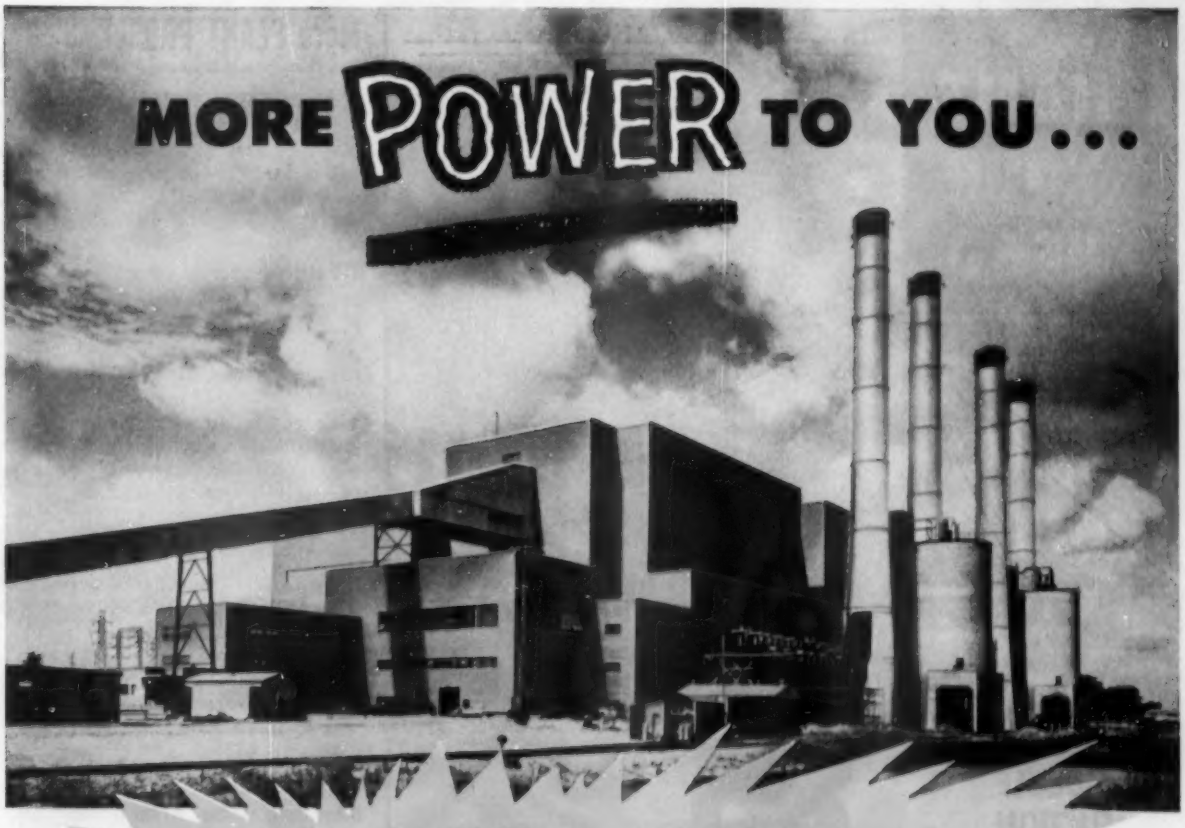
Useful tip: Instead of running a 60-gpm pump 10 minutes an hour, install a pump for cold weather rated at 10 gpm. This keeps fluid continuously on the move, reducing chances of freezeup. It also protects expensive pumping equipment against extremely cold starts.

L W FITZPATRICK
Jefferson City, Mo.

Superheated steam reduces condensation

Chief troubles with using saturated steam are pressure-drop losses and a mixture of condensate and air that has poor heat-transmission properties. Hot-water circulation avoids this trouble, but it takes a lot of pumping in a long line. Also, because of its low heat capacity compared to steam, excessive flow rates are needed for effective heating.

While superheated steam won't reduce the flow rate much when compared to saturated steam, it will lessen chances of heavy condensation and resulting impairment of heat transfer. For *GT's*



Detroit Edison Plant boosts U.S. Electrical Capacity to 100,000,000 KW.

Detroit Edison's St. Clair plant boosts U. S. generating capacity to a new high. The latest St. Clair unit, rated at 156,250 kw., to go on the line brought the total U. S. electrical capacity to over 100 million kw. Shell Turbo Oil 27 was purchased as the lubricant for this unit as well as for the other three turbine generators in this plant.

Shell Oil Company extends heartiest congratulations to Detroit Edison Company for their part in achieving this industry milestone in electrical power.

Shell is proud of its long association with the great electrical industry.

SHELL OIL COMPANY

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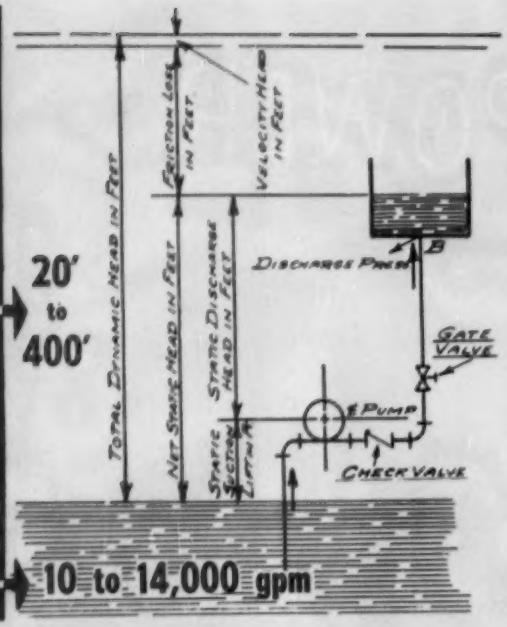
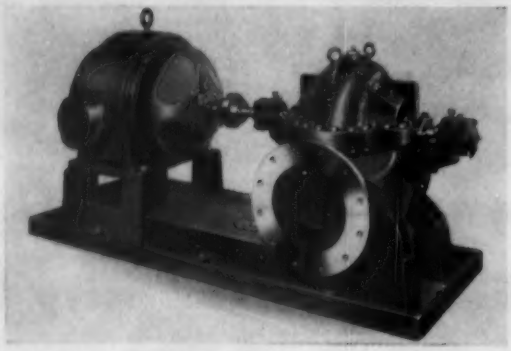
SHELL

NAME YOUR HEAD

NAME YOUR VOLUME



There's a "Buffalo" DOUBLE SUCTION PUMP FOR HIGHEST EFFICIENCY



"Buffalo" Type "SL" Double Suction Pump. Write for Bulletin 955-P for all details.

If you wish to move large volumes of clear water at heads up to 400', this Type SL Double Suction Pump is your ideal choice. It offers you:

(1) The finest construction, embodying the best accepted pump engineering features—the famous "Q" Factor*.

(2) Such a wide range of sizes (1½" to 20" pumps) that you can very accurately select the most efficient pump from its performance curve.

In addition to these pumps, "Buffalo" builds single suction, single stage and multistage centrifugal pumps for every type of service. We shall be happy to supply you with details on any of these lines —all backed by 78 years of quality pump manufacturing.

"Buffalo" PUMPS

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

BUFFALO PUMPS, INC.

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Subsidiary of Buffalo Forge Company

Canada Pumps, Ltd., Kitchener, Ont.

Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

More PLANT PROBLEMS

Begins on page 142

severe conditions, prefab pipe with built-in tracers is much better than plain pipe with a tracer strapped to it. Often, external tracers lose more heat through the lagging than is delivered to the main.

P D Hobson *State College, Pa.*

Check length of run

Relation between trace-line size and pipe size is not a key factor. More important, consider length of run in comparison to tracer size. This will set the amount of heating needed.

To prevent freezing small air lines, install them in slightly larger lines. A steam connection to the outer pipe keeps the air line from plugging.

M N Collison *Flin Flon, Manitoba*

Other readers sending good answers on tracing pipelines, for which we lacked space are:

W J Steinert	*Flushing, N. Y.*
I A Butcher	*Cincinnati, Ohio*
M Evans	*Minneapolis, Minn.*
W M Huff	*Chamois, Mo.*
C G Howarter	*Canton, Ill.*

Blowdown system (from p 146)

For 0-psig tank:
250 ÷ (3 x 15) = 5.5 sq ft
Lower limit is fixed by steam disengagement velocity. High velocity will entrain water. A German semi-empirical rule calls for one-fps maximum at 75 psig or higher. At lower pressures, maximum velocity, fps, is 90 ÷ tank pressure, psia.

For 500-psig tank:
0.9 cu ft/lb(304 ÷ 3600) ÷ 1 fps
= 0.076 sq ft

For 75-psig tank:
4.9 cu ft/lb(491 ÷ 3600) ÷ 1 fps
= 0.67 sq ft

For 0-psig tank:
26.8 cu ft/lb(250 ÷ 3600) ÷ 15/90
= 0.31 sq ft

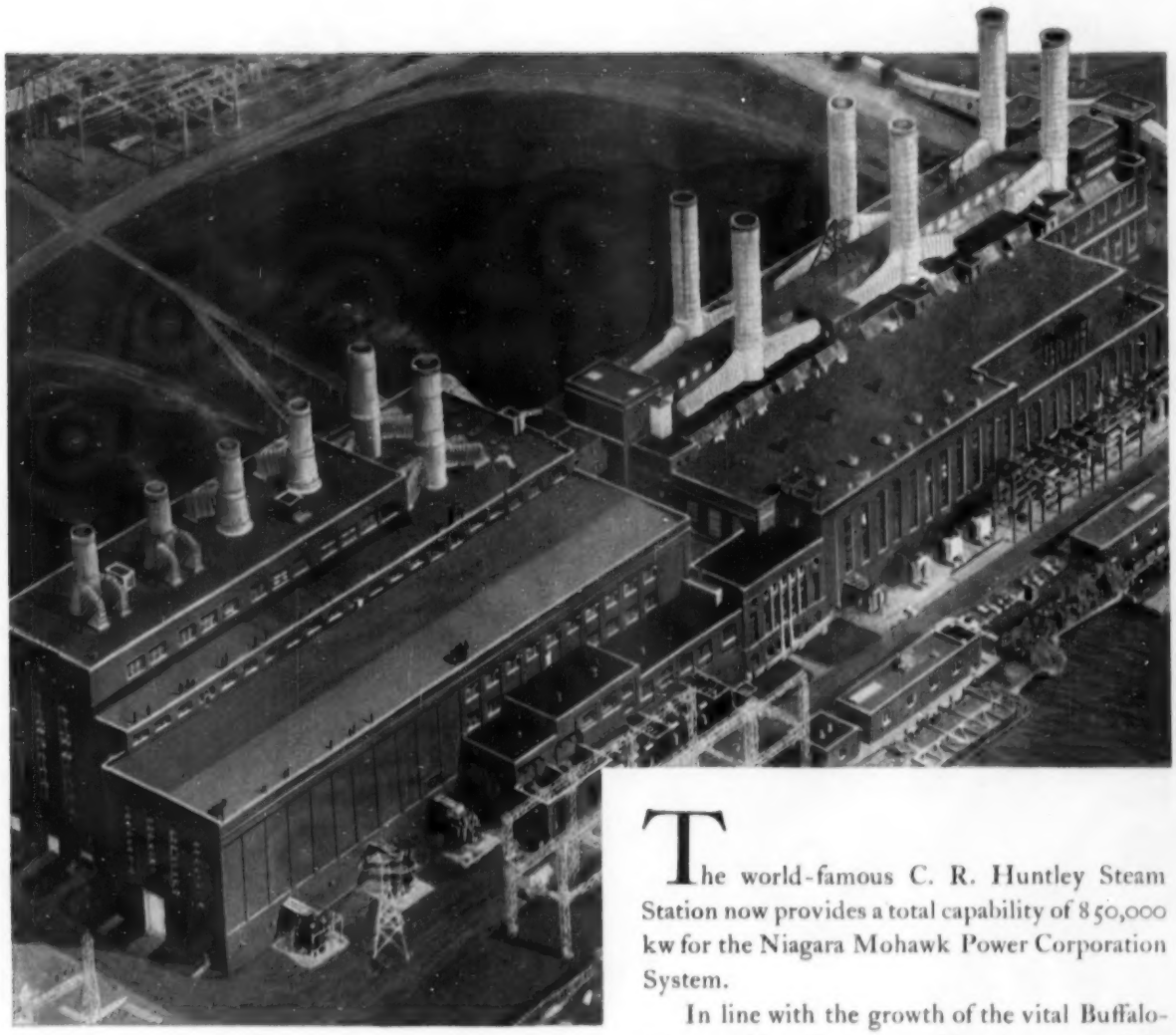
Tanks can be made from standard pipe sizes: For 500-psig use 6-in. pipe
For 75-psig use 18-in. pipe
For 0-psig use 30-in pipe

P D Hobson *State College, Pa.*

ONE BLOWDOWN TANK per boiler is best, since boiler blowdowns can be handled independently of each other—but multiple operation yields lower first cost. Heat-recovery potential can be considered on an economic basis—Btu's recovered vs cost of the blowdown system.

E F Wehlage *Fairport, N. Y.*

FEEDWATER ANALYSIS should be first step in designing a blowdown system. This is a good indication of the probable maximum blowdown. 900-psig boilers usually receive high-quality feedwater and are likely to contain a large



Two generator units, of the new hollow conductor type, each having a capability of 100,000 kw, have recently been installed at the Huntley Station on the Niagara River, near Tonawanda, N.Y.

Client SATISFACTION

The world-famous C. R. Huntley Steam Station now provides a total capability of 850,000 kw for the Niagara Mohawk Power Corporation System.

In line with the growth of the vital Buffalo-Western New York Area, Huntley—one of the largest thermal power stations in the world—has grown steadily in capacity since 1916.

The original plant was designed and constructed by Stone & Webster Engineering Corporation. The extensions of recent years have been constructed by the Engineering Corporation from designs by Niagara Mohawk's own engineers.

•

Write or call us for information as to how our experience may be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY *of* STONE & WEBSTER, INC.

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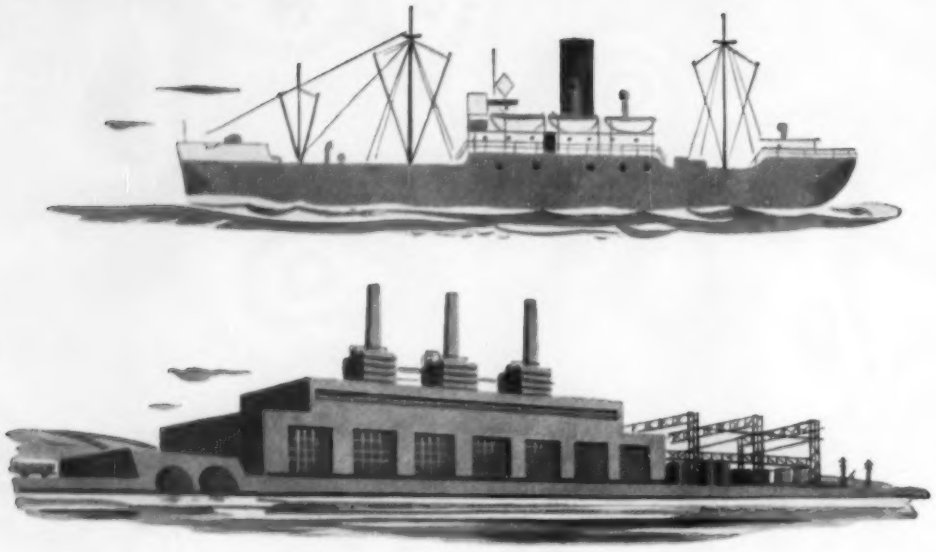
For sea-water service—



BRIDGEPORT 70-30 CUPRO NICKEL

Bridgeport 70-30 Cupro Nickel (Alloy 531) is giving excellent service in sea-water power plants, both afloat and ashore. Its resistance to general and impingement corrosion from clean sea water, especially at high velocities, offers advantages over other alloys in many applications. Metallurgists have developed Alloy 531 by adding 0.40 to 0.70% iron to ordinary 70-30 Cupro Nickel, thereby increasing its resistance even further.

Bridgeport Cupro Nickel also retains high strength at elevated temperatures, which accounts for its wide use in feedwater heaters. It is made to ASTM Specifications Bill-52, Mil-T-15005a (ships).

To use the advantages of Bridgeport Cupro Nickel, or any of the other Bridgeport Condenser Tube Alloys to solve your corrosion problems, call your nearest Bridgeport Sales Office. They'll welcome the opportunity to discuss your requirements and also to tell you about Bridgeport's Technical Service.

Want to receive our monthly Copper Alloy Bulletin regularly? Ask us to add your name to our mailing list. The Bulletin contains news about the latest developments in the condenser tube field and useful design and maintenance helps.

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valves, fittings and flanges by Vogt

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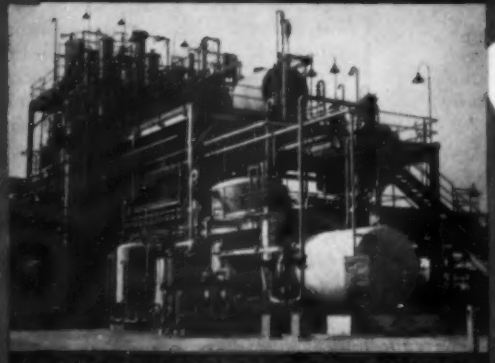


CHEMICAL PLANTS

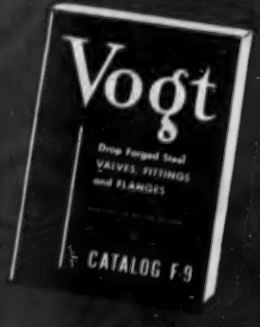
POWER PLANTS

USED and TRUSTED by the NATIONS KEY INDUSTRIES

There are good reasons behind the trust which America's key industries have placed in Vogt valves, fittings, and flanges for half a century. They know that *drop forged materials* are uniform in structure, fine grained, and free from porosity. They know, too, and appreciate the meticulous care given these products through every stage of forging and machining in Vogt's modern shops, and about the many rigid tests and inspections. And that is why these products enjoy such an impressive record of performance in withstanding the shocks and stresses imposed by high or low pressures and temperatures and in resistance to erosive and corrosive conditions.

Service is another important factor in this confidence because Vogt maintains the world's largest and most complete stock of drop forged steel valves, fittings, and flanges always ready for immediate shipment.

Write for Catalog F-9. Contains its 400 pages the complete Vogt line of drop forged steel valves, fittings, and flanges for oil, steam, water, air, gas, and other services.



HENRY VOGT MACHINE CO. 75th Anniversary

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

600 light bulbs answer to AUTOCON!

How much clearance do I have?

No longer do vigilant navigators along New York City's famed East River ask that question. Now, at any hour of the day or night, they know the accurate answer . . . constantly indicated for them by 600 light bulbs.

High above the well-traveled waterway, between Welfare Island and the borough of Queens, those 600 light bulbs keep track of tide-levels . . . measure, to the nearest foot, the distance between the bottom of a new, 6.5 million-dollar high-level bridge, and the surface of the river.

"Nerve-center" of these 600 alert light-bulbs is an eleven-circuit AUTOCON Selectrol installed on the bridge which spans the river between Welfare Island and the mainland. In this new and unusual application of AUTOCON equipment, the Selectrol measures variations in tides from 36 to 46 feet . . . and flashes the readings through a two-wire circuit to a big electric sign-board on the bridge.

Lighted numerals, twelve feet high, constantly report the changes in water-level. Through sunshine or rain, through fog, snow or darkness, helmsmen can see the numerals for a half-mile up and down the river. And constantly, they know the answer to that question . . .

. . . "How much clearance do I have?"

This East River installation is only one example of the limitless adaptability of AUTOCON equipment to any problem where control of water, through level or pressure, is a primary consideration.

For more information about AUTOCON CONTROL EQUIPMENT, the first choice of many consulting engineers, write for Bulletin 9100.

AUTOMATIC CONTROL COMPANY

1095 UNIVERSITY AVENUE
ST. PAUL 4, MINNESOTA

More PLANT PROBLEMS

Begins on page 142

percentage of returned condensate—reducing required blowdown.

I A BUTCHER *Cincinnati, Ohio*

SAFETY PRECAUTIONS must be carefully followed when one blowdown tank serves three boilers. There is always a possibility of blowback when personnel are working in boilers that are down.

L F KIRKPATRICK *Amherst, Nova Scotia*

GOOD WATER CONDITIONING keeps blowdown quantity to a minimum, reduces operating and maintenance costs. And, if blowdown can safely be kept low enough, heat-recovery equipment may not be economically justified.

C G HOWARTER *Canton, Ill.*

NEW YORK CODE lists the following requirements: (1) tank wall thickness not less than $\frac{3}{8}$ in. (2) water outlet at least twice the boiler-blowoff-line area, and extending internally to within 6 in. of tank bottom. (3) Vent, at least twice inlet diameter, should run outdoors in a direct path and discharge at least seven feet above the adjacent area—without valves, water pockets or other obstructions. (4) Provide manhole for access or cleaning. (5) Use extra-heavy pipe for 600-psig blowoff lines and higher. (6) If blowdown tank is not vented, ASME Unfired Pressure Vessel Code must be followed.

W J STEINERT *Flushing, N. Y.*

TANK VOLUME should be at least twice the water volume removed from the boiler when the drum-water level is reduced a minimum of four inches. Possibility of water carryover through the vent makes a smaller tank dangerous. This is in accord with the rules of The National Board of Boiler and Pressure Vessel Inspectors.

F LICENI *Buenos Aires, Arg.*

45° ANGLE CONNECTIONS from boiler blowdown lines to a common header reduce erosion caused by steam-water mixture at velocities normally encountered in such systems.

Use a minimum of bends, confining them to the large-radii type.

K W HALLENBECK *Long Beach, Calif.*

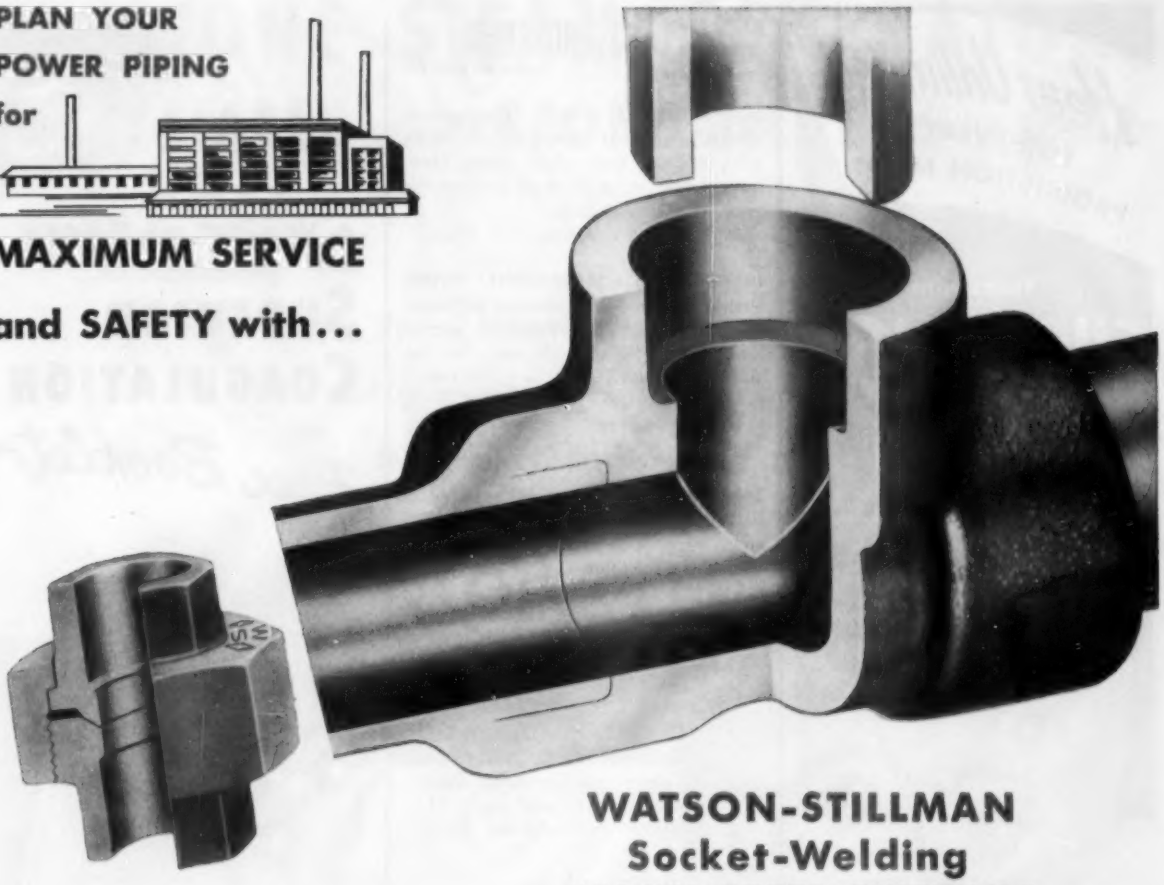
DRUM CONNECTIONS for boiler blowdown are limited to 2.5-in. diameter by ASME code, but the tank inlet line may be larger. Flow areas for tank inlet, outlet and vent should be in the ratio of 1 : 2.5 : 5.33 for boiler pressures to 150 psig. Outlet and vent sizes can be increased at higher working pressures.

W E BELL *Salem, Mich.*

(*Continued on page 216*)

PLAN YOUR POWER PIPING for

MAXIMUM SERVICE and SAFETY with...



WATSON-STILLMAN Socket-Welding ALLOY STEEL FITTINGS

1¼% Cr—½% Moly **2¼% Cr—1% Moly**

Watson-Stillman Socket-Welding Pipe Fittings provide strong, tough trouble-free joints for high pressure, high temperature steam piping. W-S high quality forged alloys are available to meet the severest conditions. They have excellent dimensional stability, good corrosion resistance and freedom from graphitization—three basic properties necessary for safe, reliable operation at high temperatures and pressures. In addition, the fibrous metallurgical structure of W-S drop-forged fittings provides extra strength and toughness to resist shock and vibration.

Watson-Stillman Socket-Welding Fittings are easy to install. Deep sockets support and align the pipe. No need for tack welding or special fixtures. Just slip the fitting over the pipe and weld.

Watson-Stillman also manufactures a complete line of Forged Screwed-End Fittings in the above alloys. All W-S fittings are also available in carbon steel and in several grades of stainless steel.

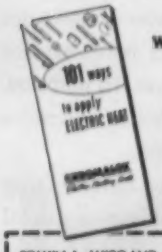
Write for information today.

WATSON-STILLMAN FITTINGS DIVISION

H. K. PORTER COMPANY, INC.

Roselle, New Jersey

Need heat for production or processing? Chromalox Electric Heaters are your quick and economical answer. Over 15,000 types, sizes and ratings to choose from to give working temperatures up to 1100°F. Temperatures controlled precisely by either manual or automatic thermostatic controls. No steam-lines, no boilers or expensive equipment to install!



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Handbook "101 Ways to Apply Electric Heat." It suggests many uses for Chromalox Electric Heater.

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Send me the illustrated booklet "101 Ways To Apply Electric Heat." A-4432

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I use heat for_____

CHROMALOX
THE BEST IN ELECTRIC HEAT

More PLANT PROBLEMS

Begins on page 142

DON'T INSTALL shutoff valves downstream of manual blowoff valves. Also, a ½-in.-thick wear plate where blowdown impinges on the tank protects the tank wall from erosion.

M Evans *Minneapolis, Minn.*

INTERMITTENT - BLOWDOWN PIPING should be run in the shortest and most direct route to insure flashing in the tank—not in the pipe. If any other hot water is dumped into the tank, run it as a separate line.

H T Livingston *Los Angeles, Calif.*

Other readers sending good answers on boiler blowdown, for which we lacked space are:

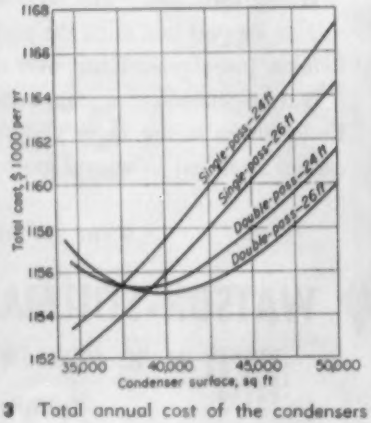
L W Fitzpatrick	*Jefferson City, Mo.*
H B Wayne	*Brooklyn, N. Y.*
G C Halzel	*Dorchester, Mass.*
E J Betke	*Detroit, Mich.*
W M Huff	*Chamois, Mo.*
J D Waid	*Cincinnati, Ohio*
R K Mitchell	*Martinsville, Va.*
E J Anderson	*Cleveland, Ohio*
R J Neiert	*Cincinnati, Ohio*
H Rasmussen	*Crystal Lake, Ill.*
M Huikko	*Litchfield, Minn.*

CONDENSER CHOICE

Continued from page 91

of the four types being considered. While differences in the annual cost between various units can be determined from Fig. 3, the actual cost values are not chargeable to the condensers since over 90% of these values consist of the fuel cost for 3812 hr at 75,000 kw.

The minimum-cost point is not reached for the two single-pass condensers in Fig. 3, but it is for both double-pass units. The curves clearly establish, however, the single-pass 26-ft effective-tube-



3 Total annual cost of the condensers

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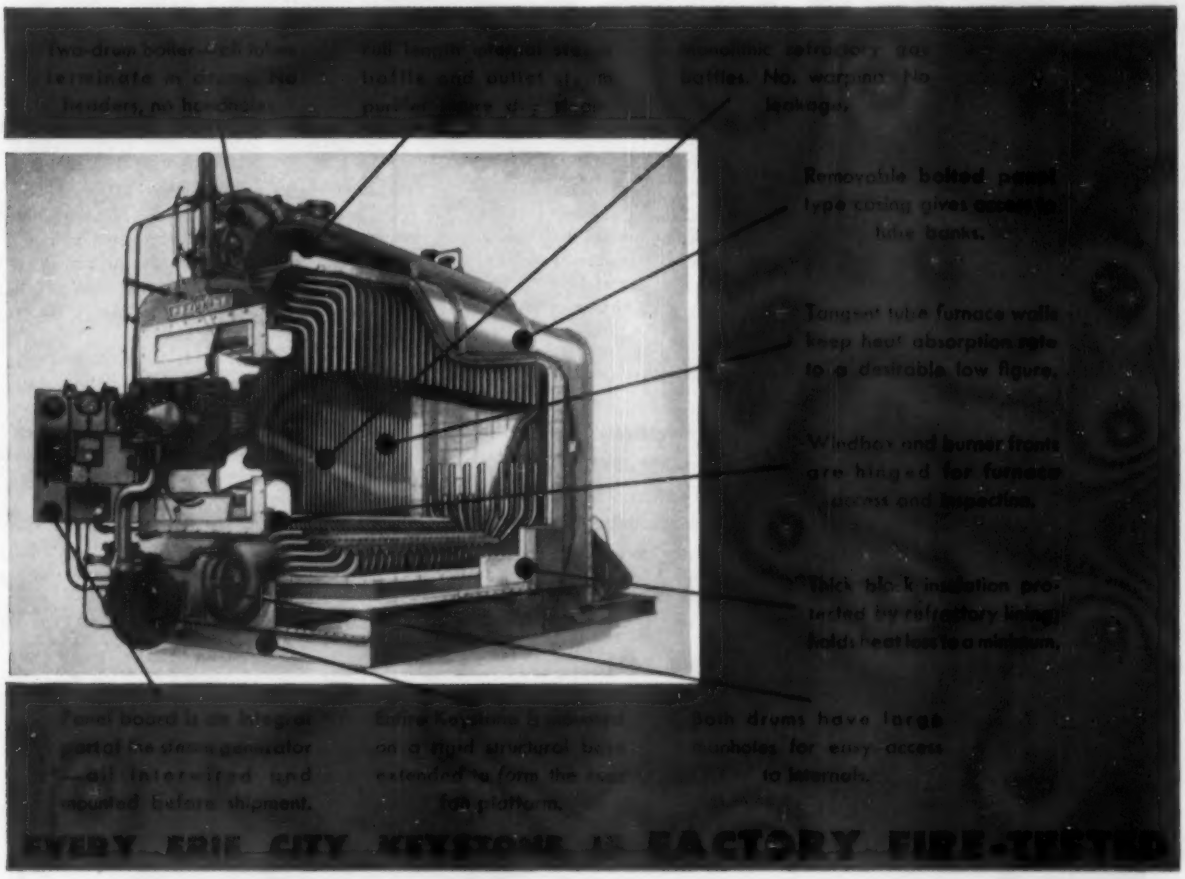
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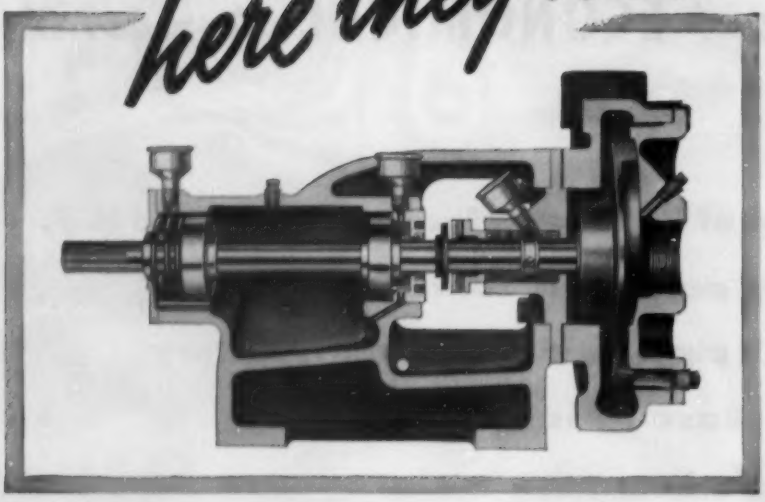
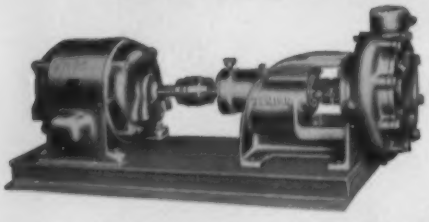


DEMING FIG. 4011 SERIES CENTRIFUGAL PUMPS



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75th ANNIVERSARY DEMING PUMPS 1880 · 1955

CONDENSER CHOICE

Continued from page 216

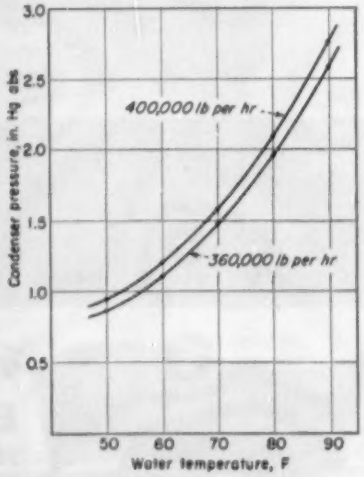
length unit as the most economical type within the range selected.

Note that although a condenser of less than 35,000 sq ft appears to be more economical, it is not necessarily the most desirable. In this instance, high circulating-water temperature could limit peak capacity to an extent that would offset the saving in initial cost resulting from choosing a smaller unit.

Maintenance. This analysis does not include a factor for maintenance cost or capacity limitation. Maintenance cost is difficult to predict, but studies show that scale-forming salts precipitate more readily at higher water temperatures. For sustained operating periods it appears desirable to maintain exit-water temperatures below 100 F in this installation. A 37,500-sq-ft single-pass condenser accomplishes this, provided its cleanliness is kept at 85%, or better.

Unit selection. A 35,000-sq-ft unit would not provide sufficient condensing margin to prevent limiting the capacity of the turbine under unfavorable operating conditions. Two possible choices remain—a 37,500- or a 40,000-sq-ft single-pass 26-ft unit. Maximum loading of a 40,000-sq-ft condenser with 400,000 lb-per-hr exhaust flow is 400,000/40,000 = 10 lb per hr per sq ft. For a 37,500-sq-ft condenser with the same exhaust flow, loading is 10.7 lb per hr per sq ft. Other similar installations have about the same loading and maximum water temperature.

While 40,000 sq ft is a particularly liberal selection, it is probably warranted because the warmest river water occurs during periods of peak load on the system. Predicted performance for two exhaust-flow conditions is shown in Fig. 4. Subsequent operation of this plant has proven the validity of the assumptions made in the analysis.



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SAFETY HEADS

Continued from page 81

linings can be satisfactorily applied to either side of the disk.

Conditions encountered will determine whether the disk should be protected on both sides. The most widely used lining, Kel-F, is a thermoplastic having 80% of its weight made up of two halogens—fluorine and chlorine. It is nonporous and satisfactorily withstands corrosive attack when subjected to many acids—nitric, sulfuric and hydrochloric, as well as caustics. There are numerous other chemicals to which Kel-F would be impervious.

Low-pressure disks. Use of prebulged metal disks is limited for systems where a low-pressure rating is required since metal selection would be limited by conditions encountered: (1) corrosive nature of the product (2) its temperature (3) a combination of (1) and (2). To eliminate these problems we developed Model 1A and 1B disks, Fig. 1. This design enables us to use metals, like nickel, monel, stainless steel, Inconel and carbon steel, in sizes from 2 through 12 in. and with pressure ratings as low as 5 to 100 psi.

This disk can be designed for systems operating under continuous positive pressure, vacuum, or alternating pressure-vacuum. The disk operates on the same principle as the prebulged type, the same rupture pattern being followed.

Product side of the disk has a Teflon or Kel-F sealing member. These materials have no effect on disk rating. Predetermined pressure of the disk is controlled by the thickness of the center plate and lapover lugs visible in Fig. 1. When the disk operates, the center plate is not dislodged because it is attached to one of the disk segments. Since the design of this disk incorporates the 30-deg angular seat, it can be used with our standard safety-head flange assembly.

As we noted in the first of this series, application of rupture disks to closed pressure systems is becoming predominant in the power, chemical, refining, aircraft, refrigeration, air-conditioning, pulp-and-paper industries, etc. These three articles, which outline typical problems met in various applications, should serve as a basic guide to all engineers who consider using a purposely designed "weak spot" in their closed pressure systems.

General Electric Co has received an $11 million order to supply eight large hydraulic turbine-generators for The Dalles Dam, U.S. Army Corps of Engineers project on the Columbia River. Shipment of the first 78,000-kw unit is scheduled for Sept, 1956.

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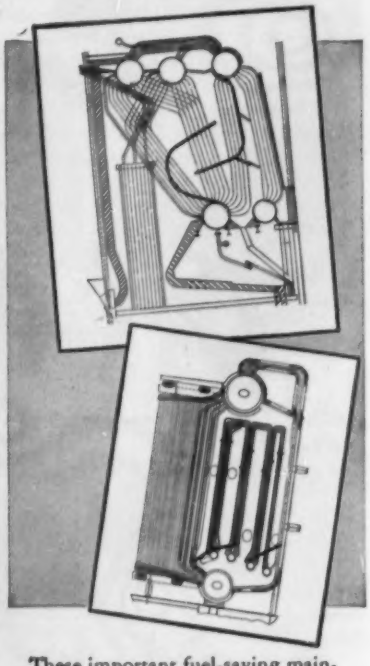

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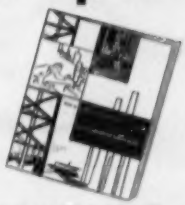

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TURBINE FLUIDS

Continued from page 79

Check these points before running machine tests

Some simple precautions should be met in running machine tests with a synthetic fluid. First off, remember both the phosphate type and the hydrolubes are excellent paint and sludge removers. Hence, system should be drained of all oil and cleaned thoroughly before adding new fluid. If supplier recommends, drain the initial charge immediately after a preliminary run. At any rate, change the filter since it will have picked up tars, varnishes and residues loosened by the synthetic fluid. Filter clogging may result if not carefully watched and elements replaced as needed.

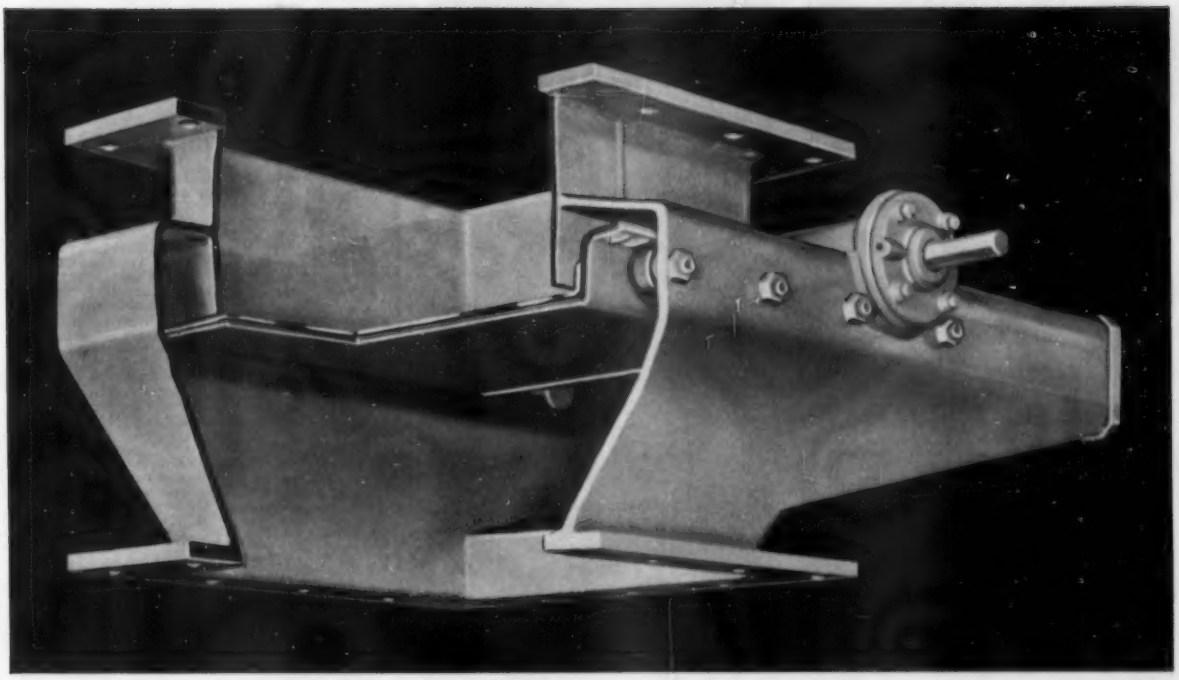
Undoubtedly some oil will remain in the system. Small amounts of oil do not affect either the hydrolubes or the phophate-ester fluids. But the more thorough the job of removing the old oil, the more fire-resistant will be the new charge. With the hydrolubes, oil rises to the top of reservoir and can be readily skimmed off.

It's tough to predict what tomorrow holds for the coming turbine fluids. Much depends on results of field tests in the immediate future. The cost differential between petroleum oil and fire-resistant fluids doesn't appear significant now in view of the possible savings and added safety in the offing.

What is the potential market for a successful fluid? Present steam-generating capacity for central stations and industrial plants is 90 million kw. A rough estimate on the average-size turbine operating today, using the Federal Power Commission's *Directory of Electric Generating Plants* as a guide, is about 50,000 kw. A safe average figure on oil capacity of a 50,000-kw unit is 2500 gallons.

We can assume, though it's far from likely, that all present turbines would swing over to a fire-resistant fluid. This would mean an immediate potential of 4½ million gallons. Then assume a 7½% annual expansion (based on generating capacity doubling in 10 years), plus an annual makeup rate of about 3%, and each year would tack on roughly another 10%.

Dutch government has asked Parliament for almost $2¼-million this year for construction of an experimental nuclear reactor. Another $2¼-million will be supplied by industry. The balance of $2¾-million would be spread over the next two years. Total costs for the project are estimated at about $7-million.



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First, notice the deep U-shaped gate which completely shields rollers, racks and pinions from coal flow. See how the gate provides lap closure on all four sides assuring positive cut-off. Also, note the stainless steel liner on top side of the gate to combat corrosion.

Carefully formed ladder racks, for their part, are self-cleaning having no root portion in which coal dust can build up and cause jamming. The multi-faced pinions, located above the racks, are also of self-cleaning design. Consequently, the gate moves smoothly with little effort, even after long periods of not being operated.

Notice the clean interior design. Slopes have been kept at a maximum with shoulders and projections eliminated. Even the poke hole covers fit flush with the inside of the valve body so that nothing interferes with flow of coal through the valve.

For a complete list of all the outstanding features of the new S-E-Co. Coal Valve together with installation photographs and dimensions, write for Bulletin No. 97.

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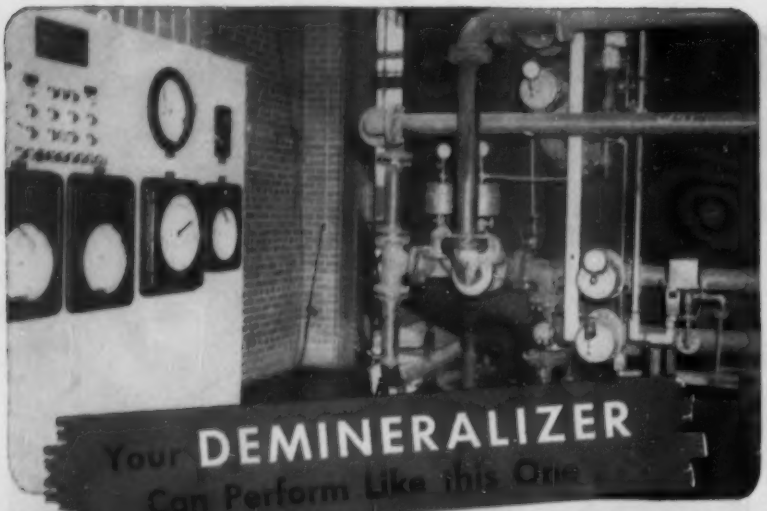

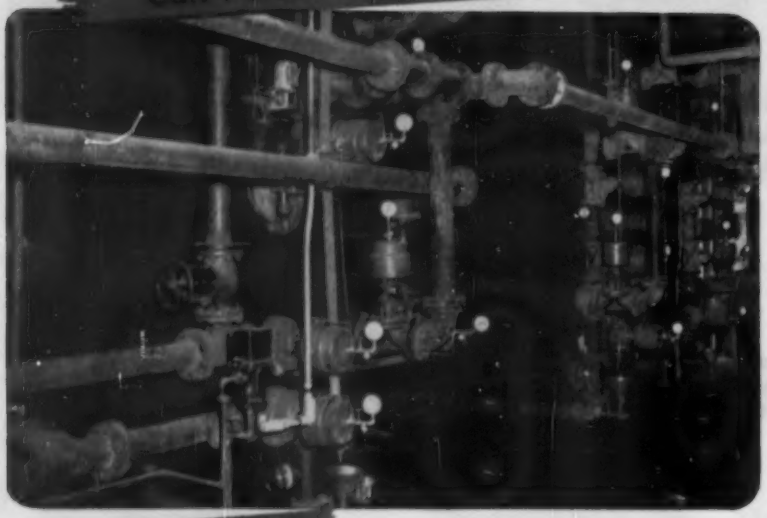

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Begins on page 175

MAINTENANCE MATERIALS

16 **Silicone products** for use as lubricants, release agents, electrical insulation, protective coatings or defoamers. Photos, charts, applications, technical data in 8-page bulletin 1-107. Dow Corning Corp, Midland, Michigan.

17 **Rust preventatives** described in 24-page bulletin 254. Includes data, photos, color chips of primer coatings, short and long oil type coatings, oil field finishes, machinery, interior and exterior finishes, heat- and chemical-resistant finishes. Rust-Oleum Corp, 2799 Oakton St, Evanston, Illinois.

18 **Cleaning and finishing** by use of wet abrasive blasting process is discussed in 18-page bulletin 451-D. Photos, applications, technical data. American Wheelabrator & Equipment Corp, 1054 S Byrkit St, Mishawaka, Indiana.

19 **Spring-lock washers.** Specs, engr data, dimensions, diagrams, charts in 16-page bulletin. Spring Washer Institute, 74 Trinity Pl, New York 6, N. Y.

MATERIALS HANDLING

20 **Spur gear hoists** with capacities from ¼ to 25 tons. Photos, cutaways, specs in 8-page bulletin YC-YCT. Coffing Hoist Co, Danville, Illinois.

21 **Electric cranes,** single girder units, with capacities from ¼ to 20 tons. Tables give clearance dimensions, maximum wheel loads and spans for top-running and underhung types. Illustrated 12-page catalog M-104. Dominion Bridge Co, Ltd, Lachine, Quebec, Canada.

22 **Overhead cranes.** Installation photos, applications of cab- and floor-controlled traveling units in 12-page bulletin 80. Whiting Corporation, Harvey, Illinois.

23 **Steel pulleys** for material conveying and power transmission. Manufacturing techniques, applications in 16-page bulletin. American Pulley Co, 4200 Wissahickon Ave, Philadelphia 29, Pennsylvania.

MECHANICAL TRANSMISSION

Double helical gears. Photos, specs, construction design, testing and applications in 12-page bulletin 1958E. Worthington Corporation, Harrison, New Jersey.

25 **Multi-V-drives.** Scientific and simplified method for rating V-belts, complete selection tables, technical data, dimensions, photos in indexed 100-page booklet V-1400-E2F. Worthington Corp, Mechanical Power Transmission division, Oil City, Pennsylvania.

METERS AND INSTRUMENTS

26 **Automatic pacing systems** tailored to solve chlorine feeding problems. Illustrated 4-page bulletin 840-K13. Builders-Providence, Inc, 345 Harris Ave, Providence 1, Rhode Island.

27 **Indexing spectrometer,** automatic multi-element unit for process control. Photos, diagrams, applications in 4-page bulletin. Mount Vernon division, North American Philips Co, Inc, 750 S Fulton Ave, Mount Vernon, N. Y.

28 **Panel voltmeters,** dc and ac expanded scale units. Tables for base voltages, spans and accuracy in illustrated 4-page bulletin 116. Arga division, Beckman Instruments, Inc, 220 Pasadena Ave, S Pasadena, California.

Megohmmeter, provides two test voltages, 50 and 500 v for measurement of high resistances. Unit will measure to 2,000,000 megohms. Photos, diagrams, applications in 4-page bulletin 873-A. General Radio Co, 275 Massachusetts Ave, Cambridge 39, Mass.

30 **Torquemeters** and their applications described in illustrated 12-page bulletin 4308. Eight torque pickups, 0-100 to 0-30,000 inch-pounds,

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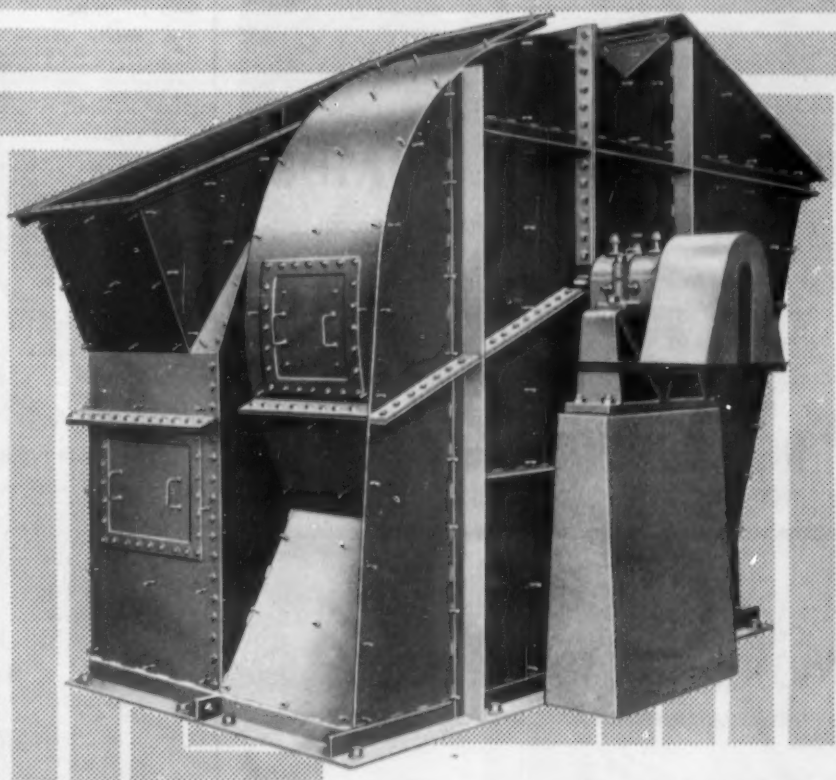

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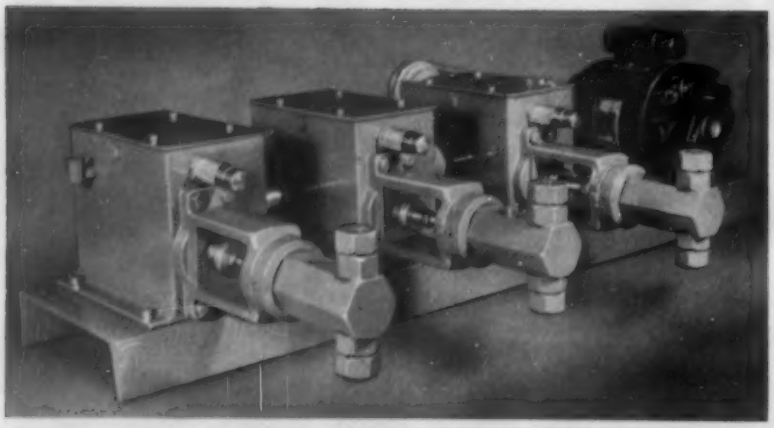

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and five types of instruments described. Baldwin-Lima-Hamilton Corp, Philadelphia 42, Pennsylvania.

VALVES, PIPING, FITTINGS AND SPECIALTIES

31 **Needle, globe,** plug, relief and check valves described in 64-page catalog 654. Includes 6000 psi selector valves, 10,000 psi needle valves, adjustable gage snubbers, and plug valves with *Teflon* plugs. Republic Manufacturing Co, 15655 Brookpark Road, Cleveland 11, Ohio.

32 **Safety valves** for pressures to 2500 psi and temperatures to 1050 F. Operating features, capacity tables, dimensions, diagrams in 16-page bulletin 400-HC. Crosby Steam Gage & Valve Co, Wrentham, Massachusetts.

33 **Strainers** for oil, water, steam and chemicals. Dimension and sizing charts, sectional drawings, application, design features in 16-page bulletin 9-S. Schutte and Koerting Co, Cornwells Heights, Bucks County, Pennsylvania.

34 **Ball float traps** for draining water from air, gas or steam lines and for draining light liquid from gas under pressure. Physical data, capacity chart, tables, diagrams and photos in 8-page bulletin 289. Armstrong Machine Works, Three Rivers, Michigan.

35 **Steel unions** and check valves. Specs of forged and stainless steel units in illustrated 22-page catalog 55. Includes published analysis of steel used. Clayton Mark & Co, 1900 Dempster St, Evanston, Illinois.

WATER TREATMENT

36 **Demineralizing** handbook compares various methods of water treatment, indicates comparison between demineralizers and evaporators. Flow diagrams, photos, selection data in 40-page bulletin 5800-B. Cochrane Corporation, 3106 N 17th St, Philadelphia 32, Pennsylvania.

37 **Deaerators,** full-contact steam-jet units described in 8-page bulletin W-210-B-32. Photos, cutaways, construction details, operation principles. Worthington Corp, Harrison, N. J.

38 **Deaerators** for oxygen removal. Operating principles, capacities, applications in illustrated 8-page bulletin 1300. Fred H Schaub Engineering Co, 2110 S Marshall Blvd, Chicago, Ill.

39 **Cooling tower water.** Illustrated 4-page bulletin offers suggestions on measurement and control of pH. Data sheet 700(1). Leeds & Northrup Co, 444 N 16th St, Philadelphia 30, Pa.

40 **Supplementary treatments** for boiler makeup water discussed in 4-page bulletin 28X8226. Allis-Chalmers Manufacturing Co, 952 S 70th St, Milwaukee, Wisconsin.

OTHER EQUIPMENT

41 **Pressure vessels** and tanks for processing industries. Photos, corrosion data tables, construction details in 48-page catalog 654. Nooter Corp, 1400 S 2nd St, St Louis, Missouri.

42 **Compressors,** heavy duty horizontal single-stage units in size from 10 to 135 hp; for pressures to 150 psi. Photos, cutaways, components, capacities and ratings in 20-page bulletin 201-C. Pennsylvania Pump & Compressor Co, Easton, Pa.

43 **Combustion gas turbines** for power generation and mechanical drives. Photos, applications, schematic drawings, cutaways, dimensions and weights in 28-page bulletin GEA-5516B. General Electric Co, Schenectady 5, N.Y.

44 **Steam jet ejectors** for air removal from condensers. Principles of operation, ejector accessories discussed in illustrated 12-page bulletin. Condenser Service and Engineering Co, Inc, Hoboken, New Jersey.

(*Continued on page 228*)

GULFCREST *is the only turbine oil that is super refined for superior performance by the ALCHLOR PROCESS*

Barrel No. 1 contains a highly refined oil that will become Gulfcrest. It has gone through the usual steps used in refining other turbine oils—but has not yet been Alchlor Processed.

Barrel No. 2 contains the part —approximately 15%—discarded by the Alchlor Process. This discarded portion contains unstable hydrocarbons which, if allowed to remain in a turbine oil, are likely to oxidize, increase neutralization number, form sludge, emulsifiers, and harmful acids.

Barrel No. 3 contains Alchlor Processed Gulfcrest—the incomparably pure lubricant that lasts longer, gives superior performance and helps keep your turbine systems clean indefinitely. To make Gulfcrest even finer, special inhibitors are added to give it still greater stability and protect against corrosion and foam.

Call your nearest Gulf office today and have a Gulf Sales Engineer recommend the proper grade of Gulfcrest Oil to meet the specific requirements of your turbines.

GULF

GULF OIL CORPORATION • GULF REFINING COMPANY • 1822 Gulf Building, Pittsburgh 30, Pa.

What every reader of...

Power

should know!

- Extra Light Density
- Easily Cut and Fitted
- Six Foot Lengths
- Resilient, Flexible
- Won't Break or Crumble
- Easy to Paint
- Highly Efficient
- No Coarse Fibers
- Takes Rough Handling
- Easily Nested
- Non-Corrosive
- Won't Rot, Decay, Mold
- Lower Applied Cost
- Factory Applied Vapor Barrier

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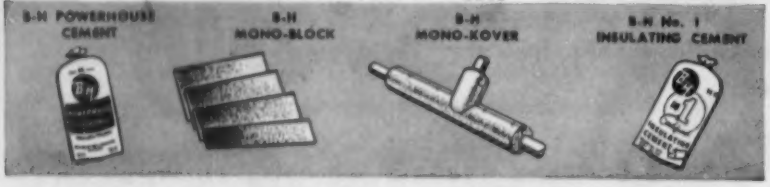
COMPANY
103 BREUNIG AVE., TRENTON, N. J.
Kalamazoo, Mich. • Huntington, Ind. • Temple, Tex.

Send for bulletin with data on how to apply, properties, selection help, sizes and thicknesses available



More FREE BULLETINS

Begins on page 175

45 **Precipitators.** Bulletin gives general principles of electrical units, has individual sections on chief applications. Photos, schematic drawings, 28 pages. Research-Cottrell, Inc, Bound Brook, New Jersey.

MISCELLANEOUS

46 **Welding chart** contains data on filler metals, recommended procedures. Arcos Corp, 1500 S 50th St, Philadelphia 43, Pa.

47 **Copper** and copper-alloy specification index. Tabbed, 24-page reference manual B-34R. The American Brass Co, Waterbury 20, Connecticut.

48 **Grating** and stair treads. Construction features, photos, sketches, typical installations in 16-page bulletin 1105. Dravo Corp, 1203 Dravo Building, Pittsburgh 20, Pa.

49 **Glass blocks** for reduction of glare and heat. Photos, physical performance in 8-page bulletin GB-103. Pittsburgh Corning Corp, One Gateway Center, Pittsburgh 22, Pennsylvania.

More POWER NEWS

Begins on page 160

Engineering grads

(*cont. from page* 160)

of Scientific Personnel, the Soviet Union has 175 university-level technical schools with combined student body of 300,000. The U.S. has a combined engineering enrollment of 150,000. Surveys indicate that courses in science and mathematics are being dropped in U.S. high schools due to lack of student interest, short supply of qualified teachers and inadequate school budgets.

Intermediate technical training schools, usually with 2-yr programs at university-level, are necessary to train men who back up engineers. Russia has 3700 such schools with 1,600,000 students. The U.S. has 1000 such schools with 50,000 students.

The Soviet picture is mirrored in the satellite countries. China has embarked on an aggressive program to develop engineering and scientific personnel. Poland, Albania, Bulgaria, Czechoslovakia, Hungary, East Germany and Rumania have active programs for technical training at the university-level with a total of 401,000 students enrolled.

The democracies of the free world, including the U.S., seem complacent about the situation.

Power conference

(*cont. from page* 160)

circuit television systems and their applications in industry; Multi-fuel boiler control; Fault location with radar equipment.

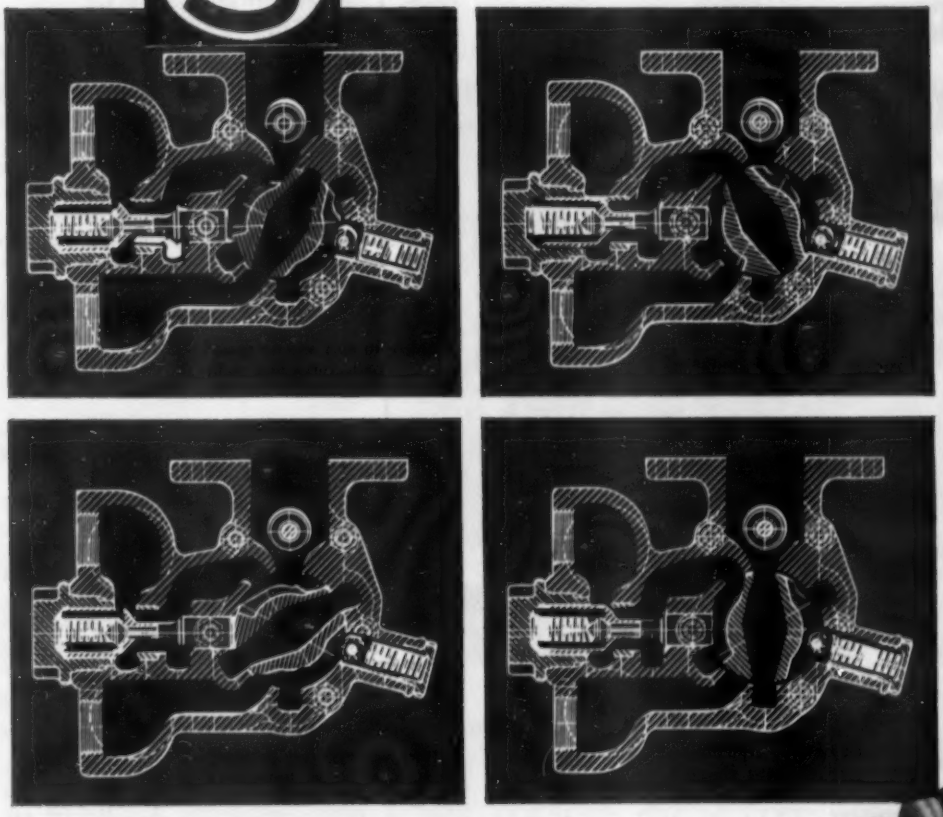
Thursday, March 31, 1955

RESEARCH IN STEAM TURBINES: Advances in large steam turbine research and development; The laboratory as an engineering tool in steam turbine research and development; Research and development in the field of turbine-gen-

CASH STANDARD

TYPE 555-RO

Four-Way Hydraulic Operating Valve



a unique rotor actuating hydraulic valve with full floating position

A Single Unit For Actuating Hydraulic Equipment

- Actuates one to three hydraulic cylinders
- Designed for 300-1500 psi pressures
- Capacity 400 GPM at 1500 psi
- Built-in by-pass effectively minimizes piston creep
- Design features ball-bearing construction and hardened wearing surfaces
- Rugged construction and precision machining assures easy operation and long service

WRITE today for Bulletin S-600

U. S. Patent No. 2360987

CASH STANDARD

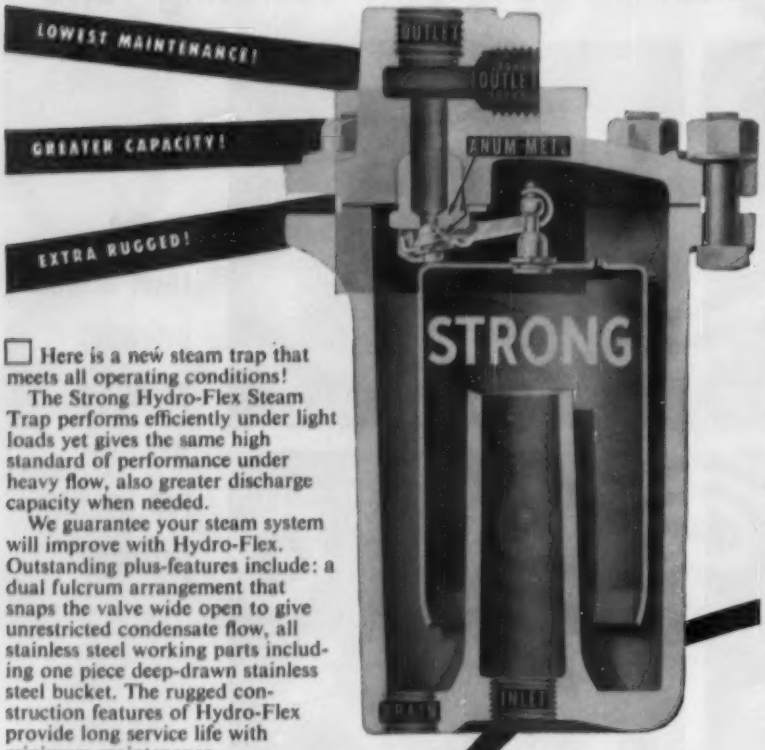
A. W. CASH COMPANY, P. O. Box 551, Decatur, Illinois

Pressure, Hydraulic, Temperature, Process and Combustion Controls

NEW WAY TO

REDUCE STEAM COSTS

AND INCREASE PRODUCTION



☐ Here is a new steam trap that meets all operating conditions!

The Strong Hydro-Flex Steam Trap performs efficiently under light loads yet gives the same high standard of performance under heavy flow, also greater discharge capacity when needed.

We guarantee your steam system will improve with Hydro-Flex. Outstanding plus-features include: a dual fulcrum arrangement that snaps the valve wide open to give unrestricted condensate flow, all stainless steel working parts including one piece deep-drawn stainless steel bucket. The rugged construction features of Hydro-Flex provide long service life with minimum maintenance.

Your local Strong distributor will give you complete information or write us for Bulletin No. SS-40.

STRONG, CARLISLE & HAMMOND COMPANY
1392 W. 3RD. STREET • CLEVELAND 13, OHIO

STRONG
HYDRO-FLEX
STEAM TRAPS

high efficiency under all condensate loads

HORIZONTAL TYPE SERIES
Hydro-Flex traps with horizontal inlet have the same features as bottom inlet types.

Available from over 200 industrial distributors in the United States, Canada and Foreign Countries.

3 types available for wide range application . . . to meet pressure and capacity requirements.

PRESSURE REGULATING VALVES

are custom sized for job demands. Bolted body permits non-threaded seats and wide selection of seat sizes.

BLOW-DOWN VALVES

STRONG STRAINERS
Offer maximum protection from dirt, scale or sediment. Available in semi steel, cast steel and bronze.

More POWER NEWS

Begins on page 160

erator prime movers in the General Electric Co.

WATER TECHNOLOGY: Demineralization of makeup for public utility plants; Demineralization of boiler feed makeup for paper mills; Treatment of makeup water with a four-bed demineralizing plant; Treatment of makeup water with automatic mixed-bed demineralizer for the Pennsylvania Electric Co.

ELECTRICAL SYSTEM PLANNING: Overall planning of systems for the long range future; Location of future generation — economic analysis; Industrial power distribution—bus duct or load centers.

CENTRAL STATION POWER PLANTS: Central station design for over-all economy; Dynamic behavior of power plant stacks under wind loading; Soil mechanics as related to power plant foundations and construction.

FUELS NO. 1: Probable trend in coal freight rates; Research in natural gas substitutes; Research in the coal industry; Research in the petroleum industry.

DEVELOPMENTS IN SMALL GAS TURBINES: Components of automotive gas turbines; Automotive gas turbines.

AUTOMATIC GENERATING EQUIPMENT FOR UTILITIES: Mobile electric automatic generating equipment for utilities; Starting requirements for isolated central station engine-driven generators.

ELECTRICAL EQUIPMENT: Use of magnetic amplifiers in excitation control; The philosophy of modern generator voltage regulators; New excitation system without commutators.

Friday, April 1, 1955

GAS TURBINES FOR POWER PLANTS: Combined gas-turbine steam-turbine power plant cycles; A 15,000-kw gas turbine power plant; Application of gas turbines to nuclear power plants.

COOLING TOWERS FOR CENTRAL STATION PLANTS: Cooling towers—their influence on prospective plant sites; Cooling towers for the power industry.

WATER TECHNOLOGY: Centralized control of boiler and feedwater chemical treatment of the Valley Steam Plant; Application and treatment of water for heat pump systems; Conditions where sticking of high pressure steam valves may occur; Blue blush characteristics; Filming amines—use and misuse in power plant water-steam cycles; experience with filming amines for improving heat transfer.

ELECTRICAL INDUSTRIAL SESSION: Series capacitors eliminate voltage fluctuations in industrial plants; Dry-type versus liquid-cooled transformers for industrial systems.

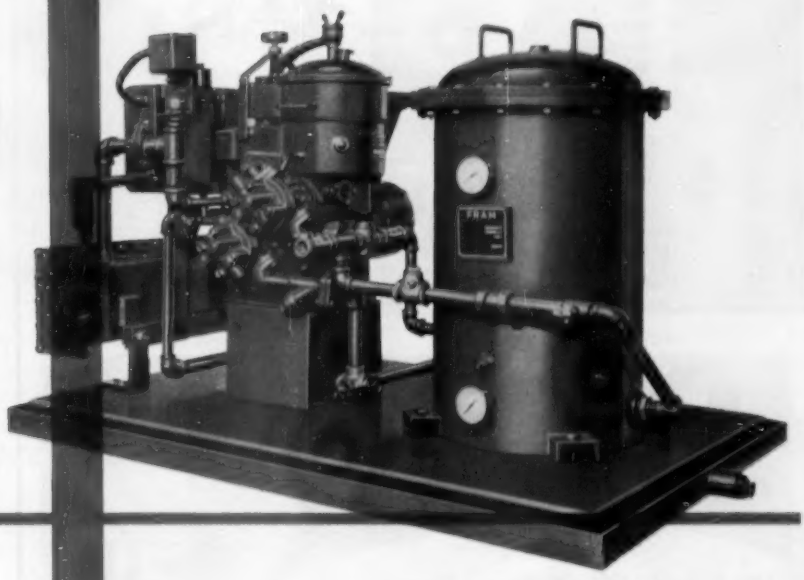
INDUSTRIAL STEAM GENERATORS: Air

Water?

Solids?

Colloidal Carbon?

THE DE LAVAL "PURI-FILTER" GETS THEM ALL!



The De Laval "Puri-Filter" is designed to remove *every* trouble-making impurity from diesel lubricating oil.

By *centrifugal* action, it takes out solid contaminants, including gum-forming solids and the water. It *filters* out colloidal carbon and other minute impurities down to *one micron* (0.000039 in.) in size.

In short, the De Laval "Puri-Filter" does a *complete* job of keeping diesel lube oil clean and dry . . . does it dependably, 24 hours a day, month after month. Investigate . . . today!

DE LAVAL
lubricating oil purifiers

THE DE LAVAL SEPARATOR COMPANY Poughkeepsie, New York • 427 Randolph St., Chicago 6 • **DE LAVAL PACIFIC CO.** 61 Beale St., San Francisco 5

Check these features!

- Easy rotary pumping action.
- Surplus liquid return eliminates spillage and waste.
- Positive displacement for positive control.
- Wide range of "plant engineered" accessories.
- Available in capacities from 7 to 28 gallons per minute.

Call your local representative or write the factory for information.

BLACKMER PUMPS

liquid materials handling ®

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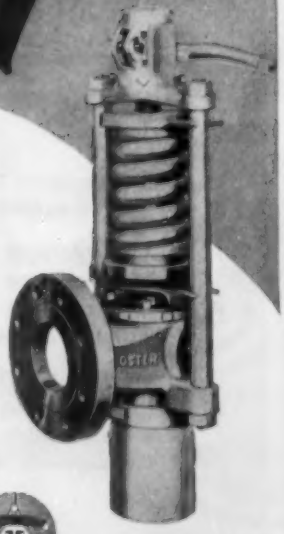
Industrial, Hand and Truck Pumps, Strainers, Pressure Control Valves
BLACKMER PUMP COMPANY, GRAND RAPIDS 9, MICH.
DIVISION SALES OFFICES — NEW YORK • ATLANTA • CHICAGO
GRAND RAPIDS • DALLAS • WASHINGTON • SAN FRANCISCO
See Yellow pages for your local sales representative

SAFEST



On thousands of boiler drums, superheater outlets, reheater inlets and reheater outlets, Foster Type 38-SV Super-Jet Safety Valves are being used for the unprecedented factor of safety they offer in today's elevated operating pressures and temperatures. Designed for 3000 psi, several Super-Jets are now in service at pressures as high as 2700 psi and 1100F.

There are also many Super-Jets set to pop at pressures ranging down to as low as 8 psi in turbine relief service and reducing valve stations.

Regardless of operating pressures or temperatures the Foster 38-SV Super-Jet Safety Valve guarantees you a positive factor of safety in protection of life, limb and property from overpressure.

75 YEARS OF AUTOMOBILES

FOSTER ENGINEERING COMPANY
835 LEHIGH AVENUE — UNION, N. J.

AUTOMATIC VALVES — SAFETY VALVES — FLOW TUBES

More POWER NEWS

Begins on page 160

preheater for small power plants; Standard steam generators.

PROGRESS IN NUCLEAR TECHNOLOGY: Reactor research and development; Sodium reactor power plant; Technology and basic economics of nuclear fuels; Power from atomic energy.

New charts available for teaching first aid

► NATIONAL SAFETY COUNCIL announces availability of 3 new safetygraphs, helpful for training small groups:

(1) "How to control bleeding." (2) "First aid treatment for burns," including treatment for frostbite, radiation and electric burns, and chemical burns of skin and eyes. (3) "Transportation of injured persons," covering examination for spine or neck injuries and use of common industrial equipment for transporting injured persons.

Write National Safety Council, 425 N Michigan Ave, Chicago 11, Ill, for further information.

Trend toward water hydraulic systems in casting operations

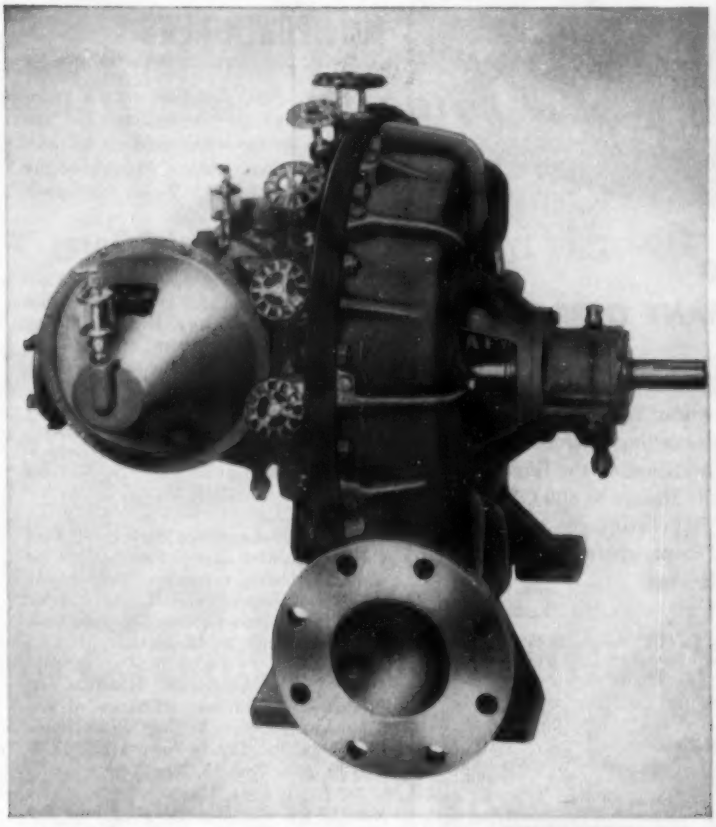
► CENTRALIZED WATER hydraulic systems are becoming popular in die casting operations, according to Alvin F Welsh, manager of Worthington Corp's reciprocating pump division. "The obvious trend toward use of water hydraulic systems by die casting manufacturers is due to such advantages as reduction of fire hazard, saving of floor space and lower cost of water," Welsh stated.

A large automobile manufacturer estimates that with oil hydraulic systems, oil losses per machine are as high as 50 gallons per month. Water, being much cheaper, affects greater operating economy. In water hydraulic systems the water is treated with from one to five percent soluble oil, thus preventing corrosion of moving parts exposed to the pumping liquid.

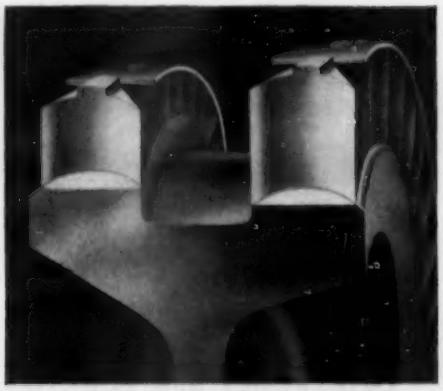
According to Welsh, in the case of oil hydraulic systems, die casters maintain individual pump and motor units for each machine. The possibility of high pressure oil leaks exist that could throw an atomized spray in the vicinity of the molten metal, risking fire. A water hydraulic system eliminates fire hazard.

Centralization of one, two or several units consisting of pumps, electric motors, steam turbines or other drives; air compressors; accumulators; and controls—feeding an entire battery of presses—reduces required floor space, provides easier maintenance and reduces the number of parts.

(*Continued on page* 234)



This is the reliable Coppus Turbine furnished with either type of wheel



Wide bucket "L" type wheel

Regular type wheel

Top performance in all COPPUS TURBINES

Both the regular type wheel or wide bucket "L" type wheel give you Coppus proven high quality and low maintenance cost. The "L" type wheel is the new development for use where low water rate is essential.

Coppus "Blue Ribbon Turbines" earned their fine reputation right on the job. Users vouch for their top quality performance and their low maintenance cost.

In the words of the supervisor of a large chemical company: "Coppus turbines require so little maintenance that a person would starve to death, if he depended on it for a living."

Proven features of *all* Coppus Turbines:

- Turbines rated close to your hp requirements, from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.

Coppus Steam Turbines ranging from 150 hp down to fractional, in 6 frame sizes, *make turbine dollars go farther.* Send for Bulletin 135 on Coppus Turbines.

COPPUS ENGINEERING CORPORATION
163 Park Avenue, Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

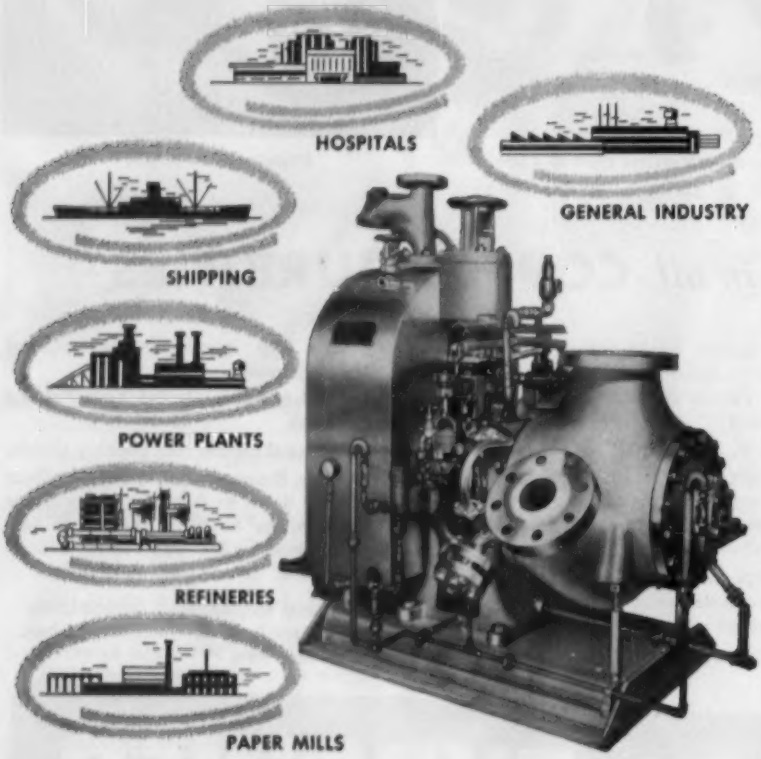
COPPUS "BLUE RIBBON" TURBINES

VERSATILITY!

ENGINEERED FOR OUTSTANDING PERFORMANCE IN MANY OPERATIONS!

On board ship, in refineries, hospitals, public utilities—in paper, textile and all general industry, the Coffin line of turbo equipment is earning nation-wide acceptance for outstanding performance. Designed with versatility in mind, latest addition to the line the Coffin "DE" Turbo Pump has a Volumetric Range to 800 GPM, Discharge Pressures to 1500 psi, Steam Temperatures to 850° F., Exhaust Pressures to 80 psig, and Liquid Temperatures to 325° F. Ratings can be exceeded in special installations.

Engineers! Write today for complete specifications. Ask for "DE" Bulletin G-110.



COFFIN MARINE RAILROAD PRODUCTS

THE J. S. COFFIN, JR. COMPANY

326 South Dean Street Englewood, New Jersey

Cable Address: COFCO

Representatives in the United States, Canada, Europe and the Far East

More POWER NEWS

Begins on page 160

"While conversions are not yet widespread, enough manufacturers are changing to the water medium to indicate future conversions throughout the die casting industry," Welsh concluded.

Calendar of Events

Mar 7-11—National Association of Corrosion Engineers, 11th annual conference and exhibition. Palmer House, Chicago, Ill. Complete information from NACE, 1061 M & M Building, Houston 2, Texas.

Mar 14-15—Steel Founders' Society of America, annual meeting. Drake Hotel, Chicago, Ill. Address queries to George K Dreher, secretary, SFSA, 920 Midland Building, Cleveland 15, Ohio.

Mar 14-18—American Society of Tool Engineers, 23rd annual meeting and 1st western industrial exposition. Shrine Auditorium and Exposition Hall, Los Angeles, Calif. Details from Denham & Co, 925 Book Building, Detroit 26, Michigan.

Mar 15-17—American Institute of Electrical Engineers, utilization of aluminum conference. William Penn Hotel, Pittsburgh, Pa. Details from AIEE, 33 W 39th St, New York 18, New York.

Mar 17-19—Air-Conditioning and Refrigeration Institute, educational conference. Atlanta, Ga. For full information write ARI, 1346 Connecticut Ave, NW, Washington, D. C.

Mar 28-29—American Institute of Electrical Engineers, materials handling conference. Hotel Cleveland, Cleveland, Ohio. Full information from AIEE, 33 W 39th St, New York 18, New York.

Mar 30-Apr 1—American Power Conference, 17th annual meeting. Sherman Hotel, Chicago. For details write to R A Budenholzer, director, APC, Illinois Institute of Technology, Technology Center, Chicago 16, Illinois.

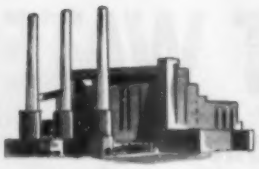
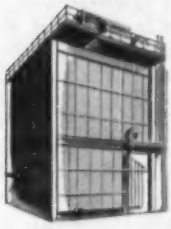
Apr 4-5—Atomic Industry Conference, Mark Hopkins Hotel, San Francisco. Details from Atomic Industrial Forum, 260 Madison Ave, New York, N. Y. or from Stanford Research Institute, Stanford, Calif.

Apr 13-15—American Institute of Electrical Engineers, Southern district meeting, St Petersburg, Fla. Details from AIEE, 33 W 39th St, New York 18, N. Y.

Apr 18-20—Third National Air Pollution Symposium, Huntington-Shearton Hotel, Pasadena, Calif. Details from Stanford Research Institute, Stanford, Calif.

Apr 27-29—Society for Experimental Stress Analysis, spring meeting. Hotel Statler, Los Angeles, Calif. Details from W M Murray, SESA, Box 168, Central Square Station, Cambridge 39, Mass.

(*More Power News on page* 236)

In the 267 new  **central station units being started in 40 different states during the 1953-56 period, 75% of the**  **boilers will be equipped with** **Consolidated Maxiflow Safety Valves ...35% will also have** **Consolidated Electromatic Relief Valves. These bulletins** **tell you why.**

Consolidated Maxiflow Safety Valve BULLETIN 707 contains data about the greater discharge capacity, permanent tightness and easily controlled blowdown that make this valve outstanding in safety and service.

Consolidated Electromatic Relief Valve BULLETIN 720 tells how this valve assures (1) more accurately balanced boiler operation; (2) more uniform line pressure; (3) power conservation; (4) less maintenance of spring-loaded safety valves; (5) greater protection against overheating your superheater; (6) increased efficiency for your steam generating plant.

Both bulletins give complete specifications. Write for copies.

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

PURE PLANT WATER

is the answer to many production problems

Depleted water supplies and a consequent degenerating quality of water has caused much concern in industry. Even a small quantity of silica sand or organic impurities in water causes increased maintenance costs and reduces the quality of many products.

Some examples

One firm's problem was the breakage of their welding tips. The welding tips would become burned, turn brittle, and then break. Dirt in the cooling water was suspected, and Sparkler diatomite filters were put on the job. The life of the welding tips was extended eight to ten times by the use of filtered water.

Another firm has produced an off-white chemical for many years. Their source of water is a highly colored river which is heavily contaminated with industrial wastes. Sand filters had been used for many years but the product always carried a color trace from the raw water. When it was decided to improve the product's color, two 400 sq. ft. Sparkler diatomite filters were installed. This firm now produces a true-white chemical and have been rewarded by an increased demand for their product.

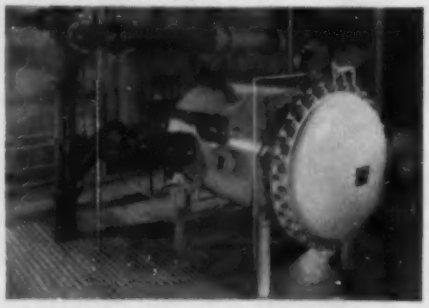
A third firm obtain their water from deep wells. The water, while fairly clear, contained a definite amount of very fine sand. This sand caused excessive wear in high head pumps and clogged fine fog nozzles interrupting production and increasing maintenance costs. Sparkler diatomite filters were installed on this four-million-gallon-a-day application and completely removed the above troubles.

The low initial cost of diatomite filters combined with their low floor space requirement and ease of operation have proved very attractive to industry. The diatomite filter will remove all silica sand, algae, organic matter and silt from water sources such as wells, rivers, or lakes. Bacteria is reduced 80% or even more in some cases. The quality of filtered water is always constant, no deterioration or variation is encountered. Add to the above that one filter can be cleaned with the output of a second filter, which eliminates the need for oversize pumps or large holding tanks for filtered water, and the reasons for the interest in diatomite filters are quite apparent.

The Sparkler Model SCJ diatomite filter is designed specifically for large volume water filtration. Available in sizes up to 2000 sq. ft. of filtering surface with capacities up to 5,000,000 gal. per day in a single unit. Multiple units engineered for larger requirements.

The original cost of a Sparkler diatomite filter is about 2/3 that of a sand filter and the floor space required less than 1/2.

Write Mr. Dan Baldwin for engineering service on your plant water problem.



Crystal clear water is obtained from a pond for plant use at Trent Tube Co. with this Sparkler Model SCJ diatomite filter. Flow rate 1,152,000 gallons per 24 hr. day operation from this single filter unit.

SPARKLER MFG. COMPANY
Mundelein, Illinois

Sparkler International Ltd.
Plants at: Galt, Ontario, Canada
Amsterdam, Holland

Sparkler Manufacturing Co., Mundelein, Illinois

☐ Have engineering representative call for consultation on our water problem. ☐ Mail plant water filtering bulletin.

*Company*_____

*Address*_____

*Individual to contact*_____

More POWER NEWS

Begins on page 160

Advisory committee named for solar energy symposium

► MEMBERS OF THE technical advisory committee for the World Symposium on Applied Solar Energy have been announced by Lewis W Douglas, general chairman. To be held in Phoenix, Ariz. on Nov 2-5, the event is co-sponsored by the Assn for Applied Solar Energy and Stanford Research Institute.

Named to the advisory committee are: C G Abbot, research associate at Smithsonian Institution; Vannevar Bush, president of Carnegie Institution of Washington; G L Cabot, chairman of board, Godfrey L Cabot, Inc; Farrington Daniels, chairman of dept of chemistry, University of Wisconsin; L J Heidt, associate professor of physical chemistry and H C Hottel, director of Fuel Research Laboratories, both at Massachusetts Institute of Technology.

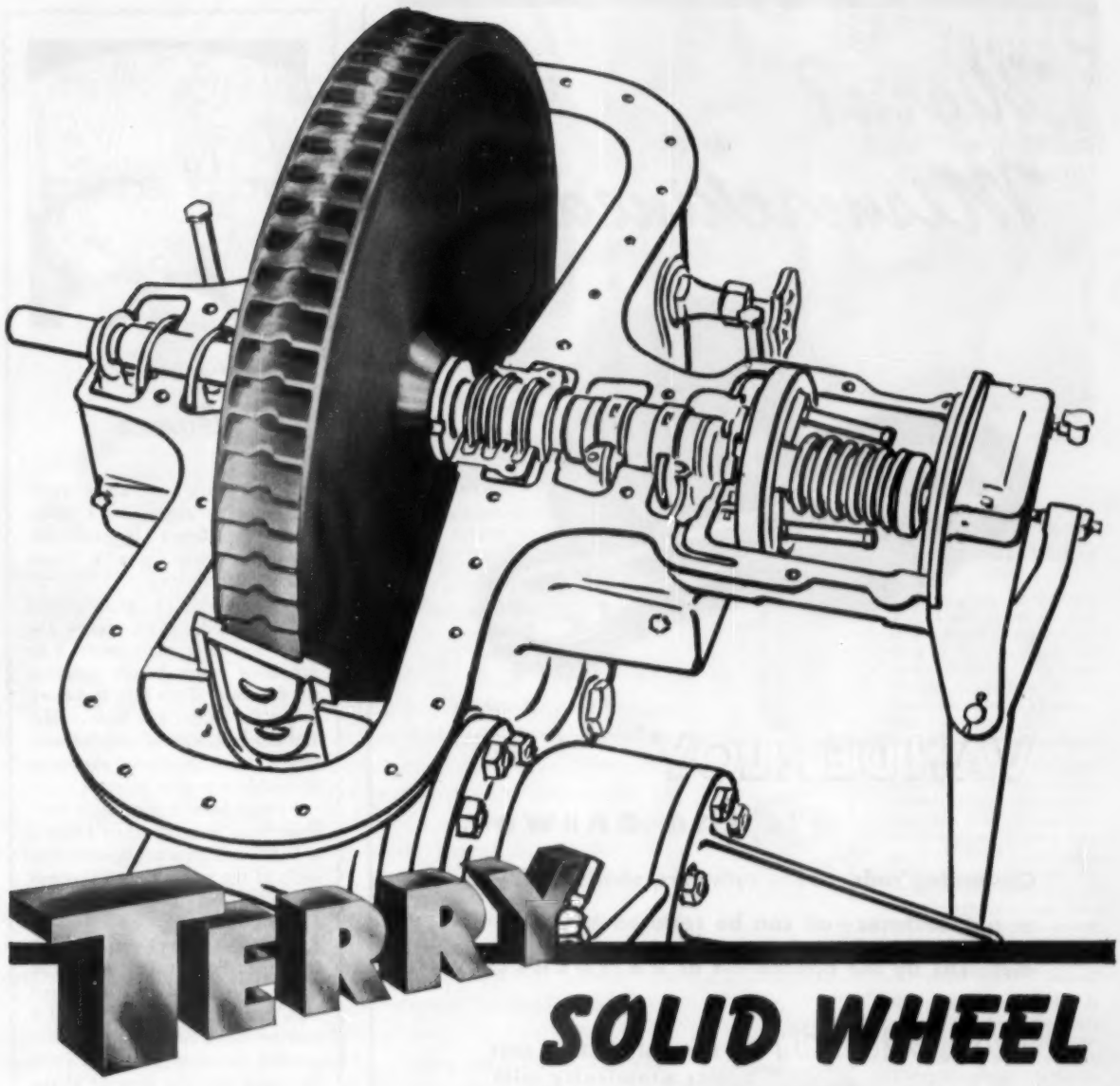
Also, Harold Heywood, asst professor, Imperial College of Science and Technology, University of London; G O G Lof, consulting chemical engineer; Eugene Rabinowitch, research professor of botany, University of Illinois; Maria Telkes, research associate, college of engineering, New York University; Felix Trombe, director of Laboratoire de l'Energie Solaire, Paris; E J Workman, president of New Mexico Institute of Mining and Technology; and F L Wright, architect.

Harry A Kuljian cited for engineering achievements

► HARRY A KULJIAN, president of The Kuljian Corp, was honored by the Pennsylvania Society of Professional Engineers as the "Engineer of 1954." Tobias Koch, chairman of the "Engineers' Week" committee, stated that Kuljian was cited for outstanding engineering achievements as a consultant, designer, and builder of world-wide stature.

Department of Water and Power, Los Angeles, Calif. has activated the second 100,000-kw generating unit at its $80-million Valley Steam plant in San Fernando Valley. Units 3 and 4 are under construction and expected to be completed late this year. They will bring total capacity at the Valley Steam plant to 512,000 kw.

Dr Charles H Lutz will form a new company known as Atomic Energy for Industry, Inc, one of the first organizations of its kind in the nation. Lutz will resign his position as specialist in electronics and the industrial applications of atomic energy for Designers for Industry, Inc. He will, however, remain affiliated with DFI as a special consultant and associate staff member.



SOLID WHEEL RUGGEDNESS

is your turbine dividend

The rugged construction and fool-proof design of a Terry solid-wheel turbine can save you money by keeping maintenance costs to a minimum. Usually only taken down for routine inspection, any repairs that must be made are of relatively simple nature, and cost of replacement parts is small.

The rotor of the turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

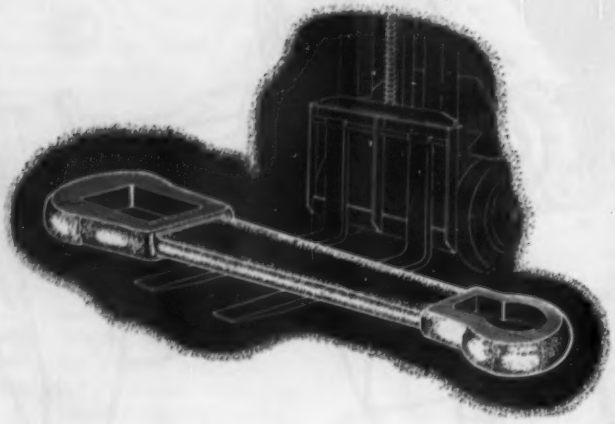
It is impossible for the blades to foul. They have large clearances and are further protected by the projecting rims of the sides of the wheel. As the side clearances are also very large, end play can do no harm.

The Terry solid-wheel turbine is an extremely reliable piece of equipment—why not write for complete details today? Ask for a copy of Bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

77-1198

Worn? Mismachined?



VANDERLOY* is the answer.

Connecting rods, power cylinders, shafts, rods—i.d. or o.d. surfaces—all can be restored to design dimensions by the application of VANDERLOY.

VANDERLOY* **an electrolytic iron that bonds atomically with most ferrous metals, aluminum, copper, nickel and their alloys.**

Write for additional information on this NEW reclamation service.
Dept. DR-2, VAN DER HORST CORPORATION, Olean, N. Y.

VAN DER HORST

TERRELL, TEXAS
OLEAN, NEW YORK
LOS ANGELES, CALIFORNIA**
HILVERSUM, HOLLAND

*Patents applied for

**SpurTan Engineering West Coast Licensee

My Biggest Boner

► Some years ago, while working as a plant electrician, I pulled a dilly of a boner. It taught our entire electrical gang a lesson worth remembering.

A slash in an underground cable needed repair. Since the cable was in a small tunnel I lit my blow torch before entering the manhole. Then I ducked down to get the solder and tools ready. But before climbing into the manhole I carefully placed the torch alongside a nearby column.

I hadn't been in the tunnel more than three minutes when I heard a frightened scream topside. The sight of the torch flashed through my mind as I stuck my head out of the manhole.

There a pretty young thing from the office stood clutching her skirt. The lower part of it had been burned away and she had a look of terror on her face.

After the excitement died down we found that she stopped at the manhole to see what was going on. She didn't see the blue flame of the torch and before she knew it her skirt was burning. Fortunately, the material did not blaze up and she got away with only a bad scare.

But it taught me to wait before lighting any torch, and if I had to put it down, to place it where I could watch it every minute.

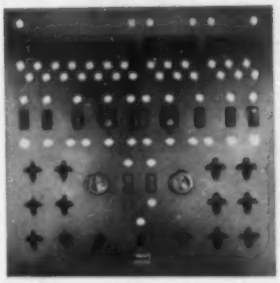
E A Roberts
CARLSBAD, N. M.

● What is your "biggest boner"? We'll pay ten dollars for each one we publish.

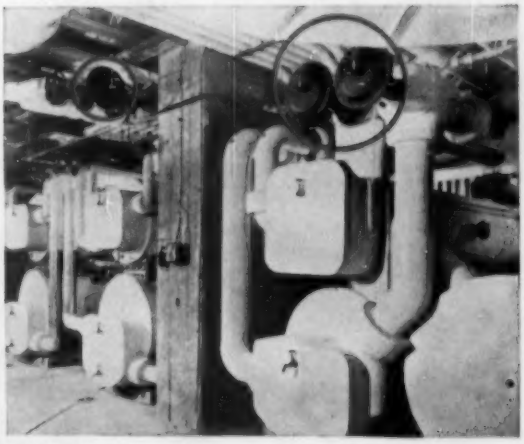
American Welding Society has formed a technical council to plan, review and coordinate all the varied technical activities of the society. Chairman of the council is I Morrison of Morrison Steel Products, Inc.

JOHNSON-CONTROLLED HEAT PUMP **CUTS COSTS** IN HALF!

The Equitable Building, Portland, Oregon. J. Donald Kroeker, engineer; Pietro Belluschi, architect; P. S. Lord, contractor, all of Portland.



Johnson Control panels permit the operation of the system to be observed from central locations.



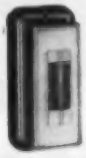
Johnson valves in command at the Trane turbo-vacuum compressors.

This world famous heat pump installation provides air conditioning for Portland's Equitable Building at less than half the average combined heating-cooling costs of other office buildings! Solving the many intricate control requirements of the heat pump and responsible for operating the system in the most efficient manner possible is a specially designed system of Johnson Automatic Control.

Year 'round air conditioning demands—usual or unusual—present no problems! *All* are controlled with precision. The whole system is the result of perfect planning . . . and this "reverse cycle" system is completely automatic. There are no definite transition points between the various cycles of operation: (1) when the demand for heating is greater than that for cooling; (2) when the need for cooling exceeds that for heating; (3) when there is a demand for cooling only. The unique control features of this interesting air conditioning system are made possible by the superior control characteristics of the highly accurate "T-900 Series" of Johnson Thermostats.

Why not cut your costs, too? Whether your temperature regulation problems demand this kind of intricate control system or a very simple arrangement of thermostats and valves or dampers, look to Johnson for the best solution. A nearby Johnson engineer will gladly make recommendations without obligation. JOHNSON SERVICE COMPANY, Milwaukee 2, Wisconsin. Direct Branch Offices in Principal Cities.

FEATURES OF JOHNSON CONTROL IN THE EQUITABLE BUILDING



The building is divided into heating and cooling zones. Most floors are arranged to provide 11 zones. Each zone is controlled separately by a Johnson Room Thermostat.

Johnson T-900 Outdoor Master Thermostats measure the external heating and cooling requirements and limit the amount of refrigeration capacity which can be brought into operation at less than design load. This reduces the electric power demand charges to the lowest possible minimum.

Refrigeration capacity is controlled by a Johnson Pneumatic Step-Controller, operated from Johnson Thermostats which measure the heating and cooling demand. The number of refrigerating compressors in operation, at any time, is determined by whichever demand (heating or cooling) is greater.

Water temperatures are varied continually for heating and cooling. Automatic control is accomplished by Johnson T-901 Submaster Thermostats commanded by a Johnson T-900 Master Thermostat which measures outdoor temperature.

JOHNSON CONTROL

TEMPERATURE ↕ AIR CONDITIONING

PLANNING • MANUFACTURING • INSTALLING • SINCE 1885

Here's POWER to clean tubes from 1/2" to 2" QUICKLY

Rotojet Junior Tube Cleaners are unusually powerful for their size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Their convenient size, speed, and ease of operation offer a marked contrast with external cleaners costing many times more.

An air valve directly behind the Rotojet motor permits one-man operation. Very little headroom is required, and either vertical or horizontal tubes can be cleaned.

Simplicity of Rotojet design and precision construction assure long service, efficient use of power, and freedom from trouble. Economical brushes, cutters, and scrapers meet practically any requirement.

Send for Bulletin J-410.

Expanding scraper and replaceable element.

Expanding brush and replaceable element.

Sectional wire brush.

Air valve for one-man operation.

ROTOJET®

Junior TUBE CLEANERS

ELLIOTT COMPANY-ROTO DIVISION

153 SUSSEX AVE. • NEWARK 1, N. J.

APPOINTMENTS

Corporation executive changes

Worthington Corp: Hobart C Ramsey, chairman of the board and chief executive officer; Howard Bruce, chairman of the executive committee; Edwin J Schwanhausser, president; Walther H Feldmann, executive vice-president; Thomas J Kehane, vice-president, sales; Charles A Butcher, vice-president, planning. **Electric Storage Battery Co:** Carl F Norberg, president. **Johns-Manville Corp:** Earl F Boyle, vice-president and general manager of Van Cleef Bros, Inc, a subsidiary.

Baldwin-Hill Co: E R Stevens, executive vice-president; M M Wilson, vice-president, sales. **Borg-Warner Corp:** William C Vokolek, vice-president and works manager of Franklin Steel div; R B Crean, president of Reflectal Corp, a subsidiary; E W Clark, vice-president of Calumet Steel div.

American Brake Shoe Co.: Harry C Platt, executive vice-president of engineered castings div. **H K Porter Co, Inc:** W Harvey Thompson and H A Chandor Jr, vice-presidents of The Riverside Metal Co div; R F Allen and C I Young, vice-presidents of Laclede-Christy Co div. **Ford, Bacon & Davis, Inc:** Charles C Whittelsey, executive vice-president; William B Poor, vice-president and director. **Lockwood Greene Engineers, Inc:** Samuel B Lincoln, chairman of the board; William J Heiser, president and treasurer; H Morgan Rogers Jr, vice-president.

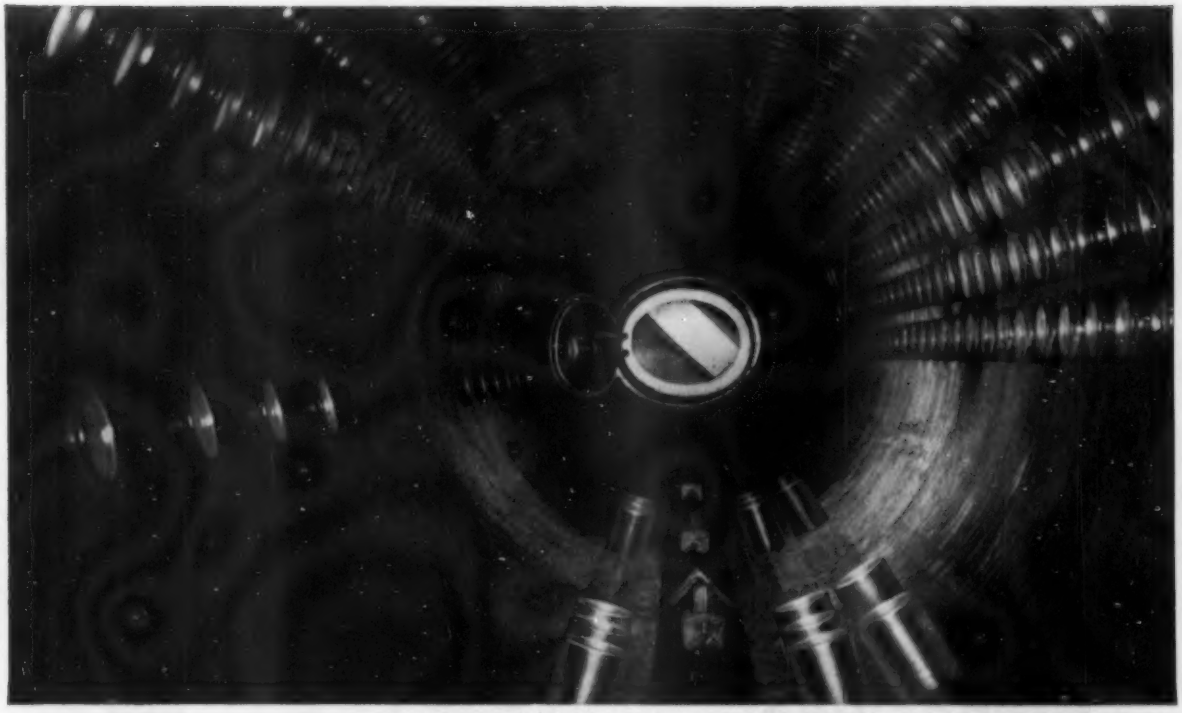
Operation executive changes

The Babcock & Wilcox Co: Tubular Products div: Sidley O Evans, manager of tubing operations; David A Edgecomb, superintendent of extrusion dept. **Cummins Engine Co, Inc:** J P Jung, Southeastern regional manager. **B-I-F Industries, Inc:** R W Pearce, works manager. **Stone & Webster Engineering Corp:** Franklin C MacKrell, Chicago district manager. **Prat-Daniel Corp:** Richard F Sharon, manager of Thermobloc div.

National Research Corp: S Sydney Minault, general manager of equipment div. **Federal Pacific Electric Co:** Howard D Tindall, manager of transformer div. **Electric Regulator Corp:** Donald B Gilman, factory manager. **Borg-Warner Corp:** A H Schmal, manager of products development laboratory. **The Swartwout Co:** Howard L Joseph, Southern California district manager. **Allis-Chalmers Manufacturing Co:** Charles W Parker Jr, manager of Richmond district.

Engineer changes

Joy Manufacturing Co: John D Russell, vice-president, engineering. **D J Murray Manufacturing Co:** S D Payzer, vice-president, engineering. **The International Nickel Co, Inc:** Robert M Wilson Jr, development engineer in



Dearborn 659* Sludge Conditioner keeps this boiler clean . . . eliminates expensive yearly cleaning.

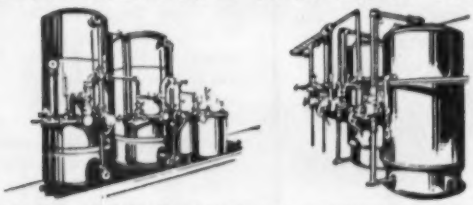
THIS IS WHAT YOU CAN EXPECT WHEN DEARBORN IS IN THE PICTURE

. . . a clean boiler throughout the year at minimum operating cost. Dearborn provides complete water conditioning and engineering service in one customized program. Tailored to meet the exact requirements of your systems. Look to Dearborn . . . the single source for those who take pride in their plant operation.

Bulletins 5000, 5008 and 5013-A should be in your file.

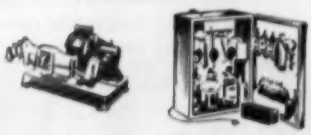
*Pat. No. Re-23085

DEARBORN EXTERNAL TREATMENT SYSTEMS



Dearborn has the knowledge and experience to design and furnish complete ion-exchange equipment, including mono-bed and 2-bed demineralizers, sodium-hydrogen split stream softeners, sodium exchange softeners either alone or in conjunction with hot lime softeners.

INTERNAL TREATMENT EQUIPMENT



Get plus results with Dearborn engineered water treatment feeding, proportioning and test equipment. Let your Dearborn engineer analyze existing equipment, plan a plant layout, and recommend the system you need.

Dearborn has specialized in the conditioning of water and the control of corrosion since 1887. This broad experience in water treatment and rust prevention—plus Dearborn's extensive research and laboratory facilities are at your service. It will pay you to consult with your Dearborn engineer.

Know your Dearborn engineer

Dearborn®

COMBATTING CORROSION EVERYWHERE SINCE 1887

DEARBORN CHEMICAL COMPANY · Merchandise Mart Plaza, Chicago 54, Illinois

A Red Hot Proposition

Buell offers you a unique opportunity to eliminate nuisance dust problems . . . without risking a single cent!

Many of America's Leading Corporations have already taken advantage of this 'red hot proposition'. Why don't you?

Just call in a Buell Engineer and put your problem in his hands. First, he will analyze dust samples from your stack, then make a thorough study of operating conditions. Finally, he will recommend the best Buell equipment to handle *your* job.

There are many variables that make each job different. One may require the fabulously successful Buell 'SF' Electric Precipitator. The simple design and proved efficiency of the Buell Cyclone may suffice for another. A third may require a combination.

The *right* equipment plus over twenty years of skill and experience enables Buell to handle *any* dust collection problem.

Take advantage of this 'red hot proposition' now. Get the complete facts about all *three* Buell systems described in our brochure—The Collection and Recovery of Industrial Dusts. Write Dept. 50-C, Buell Engineering Company, 70 Pine Street, New York 5, N. Y.

buell®

MECHANICAL ELECTRICAL

20 Years of Engineered Efficiency in
DUST COLLECTION SYSTEMS

More APPOINTMENTS

Begins on page 240

power field for development and research div. **Chain Belt Co:** Bernard Schneider, chief engineer for conveyor equipment section.

General Electric Co: Ansel H Graham, manager of engineering for small integral motor dept; W A McMorris, manager, distribution transformer advance and development engineering. **Scovill Manufacturing Co:** Charles K Stickney, chief engineer of power plants.

New sales managers

Worthington Corp: William A Meiter, general manager; Clarence S Wentworth, Central region. **Philadelphia Gear Works:** Howard Murray, general manager. **Diamond Power Specialty Corp:** Willis I McCord, electronic sales.

Westinghouse E'ectric Corp: William M McMunn, manufactured products for manufacturing and repair div. **Sylvania Electric Products Inc:** Frederick H Heintz, Midwest region for lighting products. **General Motors Corp,** Electro-Motive div: F W Walker Jr, industrial sales. **Graybar Electric Co, Inc:** W E James, Richmond district. **Hamilton Rubber Mfg Corp:** Andrew S Kaminski Jr, Chicago branch.

New sales engineers

B-I-F Industries, Inc: Robert M Gwynne, Los Angeles. **The Swartwout Co:** A Ray Wagner, Southwest district. **Whiting Corp:** T L Iwan, Ardmore (Philadelphia) district.

New distributors

For **Republic Manufacturing Co:** Power Transmission Co, 302 W Ewing St, South Bend, Ind; Air Engineering & Supply Co, 2445 Nicollet Ave, Minneapolis, Minn; Leinart Engineering Co, 332 Techwood Dr, NW, Atlanta, Ga; and Flow Engineering & Sales Co, 406 Woodland Dr, Birmingham 9, Ala. For **Strong, Carlisle & Hammond Co:** Seco Industries, Inc, 29 Broadway, New York, N. Y.; and Rhodes Equipment Co, 4485 Olive St, St Louis, Mo. For **The Parker Appliance Co:** Industrial Rubber Products Co, 505 Magee St, Pittsburgh 19, Pa, handling o-rings and related synthetic rubber products; and Keystone Pipe & Supply Co, 3232 W Fond du Lac Ave, Milwaukee 10, Wis, handling tube and hose fittings.

New representatives

For **Cleaver-Brooks Co:** Rex Bircket & Co, 424 S Cheyenne Ave, Tulsa, Okla. For **Childers Manufacturing Co:** Power Plant Efficiency Co, 901 E Maryland St, Indianapolis 6, Ind; and P J O'Meara Co, San Francisco, Calif. For **Pennsylvania Transformer Co:** Deco Engineering Products, 1112 Locust St, Des Moines 9, Iowa, and 2701 S 60th St, Omaha 6, Nebr; and Williams &

These are Zallea Pressure-Balanced Expansion Joints. They provide a sound engineering solution to the problem of absorbing pressure thrust where a change in direction occurs, and it is not possible to anchor the elbow.

Their operation is simple. Both expansion joints shown are designed to absorb axial and lateral movement in the inboard bellows. By means of tie rod action, the pressure thrust of the inboard bellows is balanced by the countermovement of the outboard bellows. This design is frequently used in piping connections to a turbine to eliminate the pressure thrust against the turbine casing. Many other applications may occur to the design engineer.

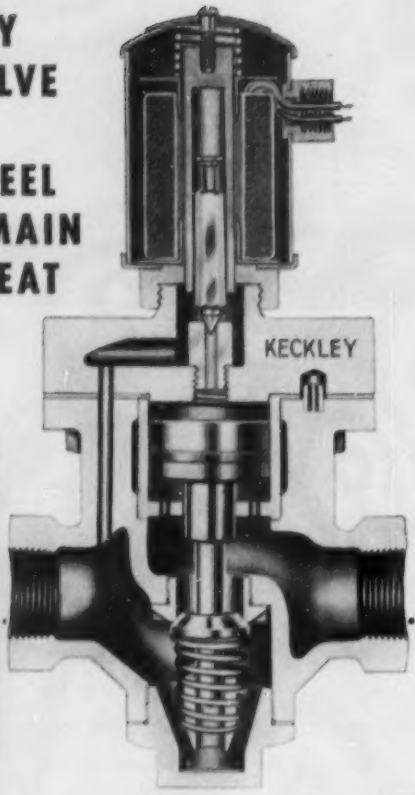
An original Zallea design, these specialized joints are another example of our ability to develop, engineer and manufacture expansion joints to meet your specific needs. For information on standard types, or help with special expansion or piping problems, call in a Zallea representative.

Zallea *expansion joints*

ZALLEA BROTHERS, 814 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints

HEAVY DUTY SOLENOID VALVE WITH STAINLESS STEEL PILOT VALVE, MAIN VALVE AND SEAT



• The heavy duty pilot operated Type EA Keckley Solenoid Valve has many features not found in all solenoid valves. Simplicity of design has eliminated many wearing parts, and parts subject to wear are renewable. The piston is located above the flow eliminating any possibility of sediment scoring the cylinder liner. Valve body assembly is the same as Keckley Pressure Regulators of equal size—parts are interchangeable.

Incorporated into these valves are the best of materials and workmanship.

Order one for a test in your plant—no obligation. Write for details—Catalog 54-A.

SPECIFICATIONS

TYPE EA SOLENOID VALVES

Maximum Steam Pressure—250 lbs.
Maximum Air, Water, Oil and Gas Pressure—600 lbs.
Sizes ½" to 6" with Bronze or Semi-steel Bodies
Pilot Valve, Main Valve and Seat—Stainless Steel
Cylinder Well—Bronze or Monel
Coils—Heavy Duty, Glass Insulated, Moisture Proof

O. C. KECKLEY COMPANY
400 W. MADISON ST.
CHICAGO 6, ILLINOIS

Pressure Regulators • Temperature Regulators • Float Valves
Strainers • Solenoid Valves • Reducing Valves
Pop Safety Valves • Relief Valves

KECKLEY CHICAGO

More APPOINTMENTS

Begins on page 240

McKinley Sales Co, 1012 Baltimore Building, Kansas City, Mo. For **Calumet & Hecla, Inc,** Wolverine Tube div: A B Murray Co, Elizabeth, N. J. For **Electric Regulator Corp:** Radio-Technical Sales Co, Kansas City, Mo; Brookfield & Co, Philadelphia, Pa; Alan E DeCew Agency, Sodus, N. Y.; and Robert E Nesbitt Co, Dallas, Tex.

For **Darling Valve & Manufacturing Co:** Lewis M Poag, 3642 Bellecrest Ave, Cincinnati, Ohio. For **R P Adams Co, Inc:** A N Dunn, South Bend, Ind; and Ross Engineering Co, 224 S Michigan Ave, Chicago 4, Ill. For **Carver Pump Co** and for **The National Supply Co,** engine div: Robert Goldsmith Co, 114 E 32nd St, New York 16, N. Y. For **Conoflow Corp:** Williams Equipment Co, New Orleans, La; and Engineered Instrument Sales Co, Memphis, Tenn. For **Hungerford & Terry, Inc:** DuBois-Webb Co, 19951 James Couzens Hgwy, Detroit, Mich; and Ross Engineering Co, 224 S Michigan Ave, Chicago 4, Illinois.

Recent purchases, mergers

Eclipse Fuel Engineering Co: purchase of assets of The Mettler Co, Inc. **Chicago Belting Co:** consolidation with two subsidiaries, Allis Rubber Corp, and Allis Seal Corp, to form Chicago-Allis Mfg Corp. **American Meter Co:** acquisition of The Philadelphia Pump and Machinery Co, Inc, to be operated as a subsidiary.

Recent moves

Republic Manufacturing Co: to new building at 15655 Brookpark Rd, Cleveland 11, Ohio. **Worthington Corp:** Detroit office to 13305 Puritan Ave, Detroit, Mich. **Harry Terry:** to 110 E 42nd St, New York 17, N. Y. **Burndy Engineering Co, Inc:** New York sales office to 20 E First St, Mount Vernon, N. Y. **Simplex Valve & Meter Co:** to 7 E Orange St, Lancaster, Pa. **Johnson Service Co:** Central district headquarters to 2201 W Howard St, Evanston, Ill. **Vanton Pump & Equipment Corp:** executive and sales offices to 201 Sweetland Ave, Hillside, N. J.

New branch offices

American Blower Corp: at Central-Madison Building, 128 S Central Ave, Phoenix, Ariz, S A Meier, manager. **Whiting Corp:** at 1610 Liberty Life Building, Charlotte 2, N. C., Fred W Fisher, manager. **Graver Water Conditioning Co:** at 5343 McCormick St, Houston, Texas, J J Hanratty, manager.

Bailey Meter Co: at 6331 Aberdeen Ave, Dallas 30, Tex, F D Krusemark, manager; and at 3256 Hendricks Ave, Memphis 11, Tenn, R E Byers, manager. **National Vulcanized Fibre Co:** at Industrial Office Building, Newark, N. J., Samuel Sinclair, manager. **Darling Valve & Manufacturing Co:** at 30 N

Permanently grounded for complete protection

Just as important as the equipment that goes into a new utility or sub station is the protection of that equipment. Grounding of every unit is an important part of that protection. For the best GROUNDING system possible, specify CADWELD electrical connections. They are permanent, cannot loosen or corrode and have a greater current carrying capacity than the conductor itself.

CADWELD®

Erico Products, Inc.

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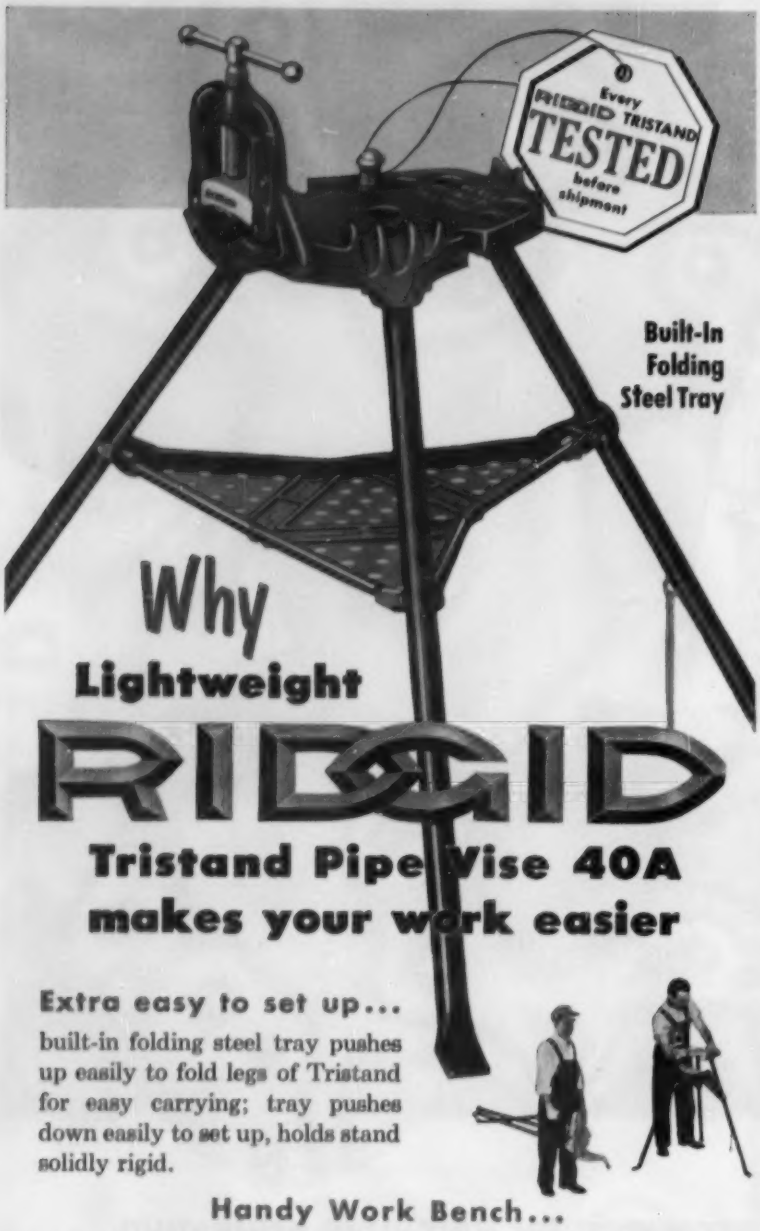
IN CANADA: ERICO INCORPORATED, 3571 Dundas St., West, Toronto 9, Ontario



Why Lightweight RIDGID Tristand Pipe Vise 40A makes your work easier

Extra easy to set up...

built-in folding steel tray pushes up easily to fold legs of Tristand for easy carrying; tray pushes down easily to set up, holds stand solidly rigid.

Handy Work Bench...

extra-strong stand and tray all one unit. Full size vise-base has 3 benders, ceiling brace screw, lots of tool slots, besides handy tool tray. Most for your money—your Supply House has them, can demonstrate and deliver fast!

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U.S.A.

RIDGID Work-Saver Pipe Tools

More APPOINTMENTS

Begins on page 240

LaSalle St, Chicago, Ill, B E Engstrom, manager. **Pennsylvania Transformer Co:** at 472 S Salina St, Empire Building, Syracuse 2, N. Y., J B Sullivan, manager.

Awards

Harry A Winne: John Fritz medal for distinguished leadership in electrical industry. **Oliver T Buckley:** AIEE Edison medal. **Ruben F Mettler:** Eta Kappa Nu recognition award.

Retirements

E D Treanor: transformer designer for General Electric Co. **S Wyman Rolph:** president, chairman of the board and director of Electric Storage Battery Co. **Ralph W Geauque,** Mid-Atlantic district representative for The Deming Co. **E T Parsons:** Philadelphia-Camden district representative for The Garlock Packing Co. **Donald P Vail:** Los Angeles district manager for C C Moore & Co.

Harry E Smith: vice-president in charge of rubber products sales, director and executive committee member for Raybestos-Manhattan, Inc. **Samuel G Hibben,** director of applied lighting for lamp division of Westinghouse Electric Corp, and past president of Illuminating Engineering Society.

Obituaries

Dr Max Jakob, 75, research professor of mechanical engineering at Illinois Institute of Technology and consultant in heat research at Armour Research Foundation, on January 4th.

Accident rates, 1954 series of booklets published by the National Safety Council, 425 N Michigan Ave, Chicago 11, Ill., shows current accident rates for the industries involved, and also gives a historical rundown of rates for some years back.

Booklets are published for each of 15 industrial groups, including chemical and rubber; communications, electric and gas utilities; construction; iron and steel products, non-ferrous metals; machinery, electrical equipment; steel, foundry; textile. Prices available on request to council.

1955 AWARD PROGRAM

Have you recently modernized any of your power services? Tell us about it. You may be in the 1955 award picture. See p 85

Addressograph-Multigraph saves 29% in fuel costs burning coal the modern way

The Addressograph-Multigraph Corporation has a modern plant in suburban Cleveland. For economy and efficiency, the firm's boiler plant is coal-fired and boasts the latest in coal and ash handling equipment.

Coal offers many advantages to Addressograph-Multigraph. It is easy to handle. Only one man per shift is required to run the boiler plant on a 24-hour basis. There is no air pollution problem. And best of all is the low cost of operation! Coal costs 29.6% less than the next cheapest fuel and 35% less than the third one! With these benefits, no wonder Addressograph-Multigraph is a satisfied user of coal!

Investigate Your Fuel Costs

If you're planning to modernize your plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal, burned the modern way, compares to other fuels. Talk to a consulting engineer or your nearest coal distributor. Their advice may save you thousands of dollars every year.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available.

Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar.

Automatic coal and ash handling systems can result in a virtually labor-free plant.

Coal is the safest fuel to store and use. No dust or smoke problems when coal is burned with modern equipment.

Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building, Washington 5, D.C.

Choose WESTERN
for Chemical Treatment of Water, Steam and Fuel

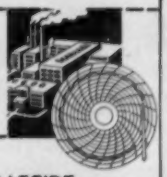
Look them over! Check your needs! Every Western product for treatment of water, steam or fuel is proved in use, technically formulated for each individual problem.

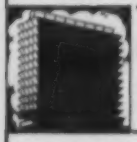
1 *Steam* + CORAVOL® = *Protection* (FROM CORROSION)

CORAVOL circulating throughout your steam system protects it from corrosive attack; cleans out rust deposits; increases heating and operating efficiency; reduces maintenance and labor costs. CORAVOL is the *original amine process* developed by Western Chemical Company.

2 WESTERN BOILER FEED WATER TREATMENT

Special formulas for each individual boiler water and operating condition to eliminate scale, corrosion and foaming.





3 COOLING WATER TREATMENT AND ALGAECIDE

Prevents scale deposit, corrosion, and algae growth in every type of cooling and condenser water system.

4 BRINE AND SWEET WATER TREATMENT

Prevents corrosion and protects tanks and equipment in refrigerating brine and sweet water systems.

5 WESTO HOT WATER TREATMENT

Stops corrosion and scaling in hot water supply tanks and lines, maintaining service without impairing potability.

6 WESTERN LIGHTNING TREATMENT

Disintegrates and removes scale quickly from water jackets, cylinder heads, condensers, compressors, lines, coils, pumps.

7 WESTERN ALUMINA NO. 45

Provides efficient coagulation in raw water ice manufacture, lime and soda softeners, water supply clarification.

8 WESTERN SOOT REMOVER

Removes and prevents soot deposits in combustion areas, thus increasing fuel economy and boiler capacity.

9 WESTERN FUEL OIL SLUDGE DISPERSANT

Eliminates sludge and moisture in fuel oil, effecting clean tanks, lines, and burners, and improved combustion.

Chemical Treatment for Water Steam and Fuel

WESTERN CHEMICAL COMPANY

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Kansas City 5, Missouri

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Kansas City 5, Missouri

Send me full information about products checked.

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Firm

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BOOKSHELF

Fresh Water From the Ocean. *By Cecil B Ellis and members of the staff of Nuclear Development Associates, Inc. 218 pp. 6¼x 9¼, cloth, 41 illus, tables. $5.00. The Ronald Press Co, 15 East 26th St, New York 10, N. Y.*

This book reports results of a study to determine if fresh water could be extracted from the ocean on a large scale—one thousand million gallons a day—at a price that could be met by cities, industries and irrigation projects in need of water. Within no longer than, say, 10 years from now it should be possible to extract fresh water from the ocean on a large scale at a total cost of about 30c per 1000 gallons at a cheap-power location. For interior areas, cost of pumping from seacoast must be added to this figure.

This general price level is believed to be within financial reach of many large cities and industries. In the U.S., such consumers usually have access to river water at a much lower cost.

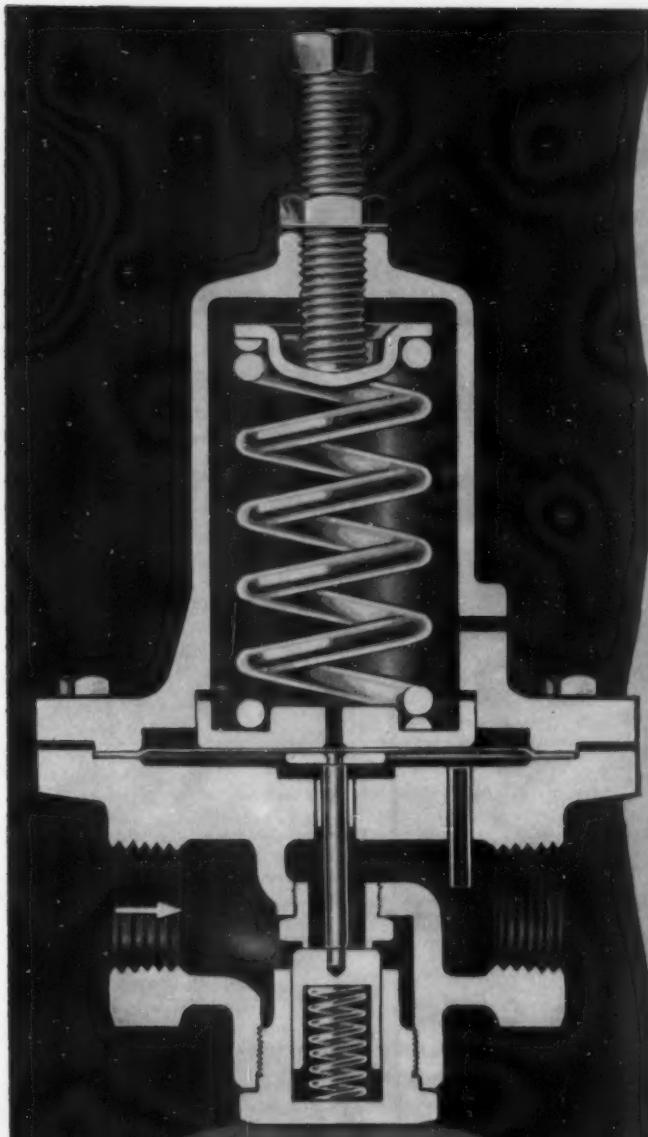
Of many processes now known for purifying sea water, the electric membrane method is expected to be the cheapest. Depending on new membrane materials developed in the last two years, it is not now possible to quote exact costs for a large plant that might be built with these new materials at some future date. The promise of the membranes is so great, however, that predicted cost seems based on adequate foundations.

Anyone interested in long-range water problems should make this book part of his required reading because it gives an excellent picture of the many factors that must be considered.

Engineering Formulas and Tables (*Revised edition*). *3¾x6¾, 350 pp, loose-leaf; 1-in. metal-ring binder, imitation leather, tabbed indexes, $4.75 (sheets in 2-pin binder $2.75), LEFAX, Sheridan Bldg, 9th & Sansom Sts, Philadelphia 7, Pa.*

These data sheets cover three branches of engineering: civil, mechanical and electrical. The 12 tabbed sections include: (1) Mathematics—arithmetic review, algebra, logarithms, areas of plane and irregular figures, formulas, trigonometry, analytic geometry and calculus. (2) Measures—weights, lengths, surface, volume, unit systems, work, power, energy. (3) Materials—strengths, specific gravities, weights, air density, specific heats, psychrometric chart. (4) Gages, screws, etc—gage systems, screw thread terminology, standards, limits and fits for engineering and manufacturing, drills, keys and keyways. (5) Mechanics—principles, statics, dynamics, rotation, friction, centers of gravity.

(6) Electricity and magnetism—units, formulas, electric and magnetic circuits, alternating current, voltmeter, wheatstone bridge. (7) Hydraulics—hydrostatics, pumping power, pipe flow, valve and fitting resistances. (8) Structural data—definitions, deflections and moments of beams, coefficients for stresses and lengths of members in roof trusses, bridges, floor



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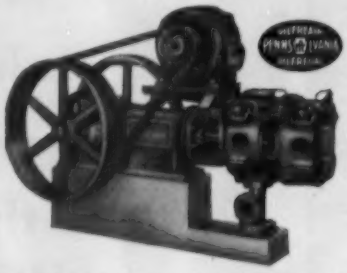

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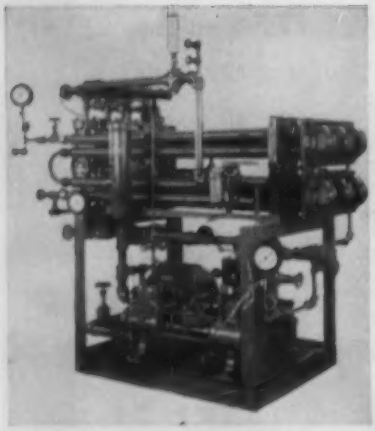

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Begins on page 248

loads. (9) Reinforced concrete—guide, properties of common sections of beams, design and investigation of rectangular concrete beams, etc. (10) Pipe and fittings—specifications of welded and seamless steel pipe, cast iron pipe flanges, pipe threads, etc. (11) Steam tables—mollier diagram, properties of saturated and superheated steam. (12) Mathematical tables—decimal equivalents, four-place natural logs, trig functions, useful functions.

Steam, Air, and Gas Power (*Fifth edition*). *By William H Severns, professor of mechanical engineering, University of Illinois, Howard E Degler, technical director, Marley Co, and John C Miles, professor of mechanical engineering, University of Illinois. 5½x8½, 502 pp, 297 illus, tables, $6.50. John Wiley & Sons, Inc, 440 4th Ave, New York 16, N. Y.*

Heavy emphasis is placed on the thermodynamic analysis of power machinery in this edition. Several changes have been made in this edition in addition to rewriting most chapters. First two chapters explain the terminology of heat power and arrangement of modern plants. The general energy equation is applied to steady flow processes of practical machines. Expanded coverage has been given to liquid and gaseous fuels compared to previous editions. Centrifugal and axial flow compressors are considered in the chapter on air compression.

Electric Power Stations (*Fourth edition*) *Volume I. By T H Carr, formerly city electrical engineer and manager, Bradford Corp. 5½x8½, 605 pp, 315 illus, tables, 70 shillings ($9.80). Chapman & Hall Ltd, 37 Essex St, London, W.C.2, England.*

Revision and enlargement of this book expands on information pertaining to British power plant practice. This volume starts with factors considered in choosing power plant specifications. It then develops discussion on various specialties within the plant such as: structures, cooling water systems, cooling towers, coal handling, ash handling, boilers, pipework and turbines. Design and operating considerations are covered in the general discussion.

National Electrical Code Handbook. (*Eighth Edition*). *Revised by Charles L. Smith, electrical field engineer, National Fire Protection Assn. 642 pp, 6 x 8 in. $7.50. McGraw-Hill Book Co., 330 W. 42nd Street, New York 36, N. Y.*

The many former editions of this book, prepared by Arthur L Abbott, have kept electrical men reliably informed on the meaning and intent of the National Electrical Code's various rules. Handbook explains the NEC rules in brief, easy-to-understand language. It gives the plan, scope and intent of Code requirements.

Present edition contains all the changes reflected in the 1953 Edition of the Code. Book format has been changed; various sections of the book are numbered to correspond with the Code. Actual language of the Code is given, then, in the authors words and in contrasting typeface, the meaning of that particular rule is clarified.

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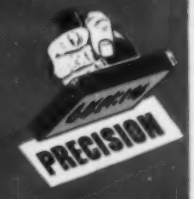

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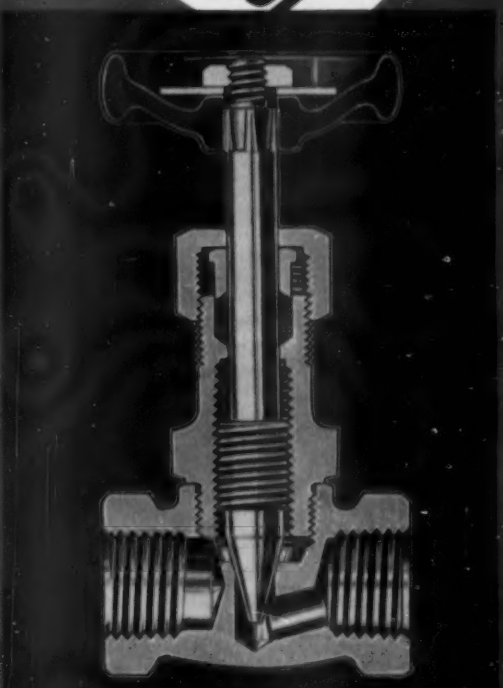

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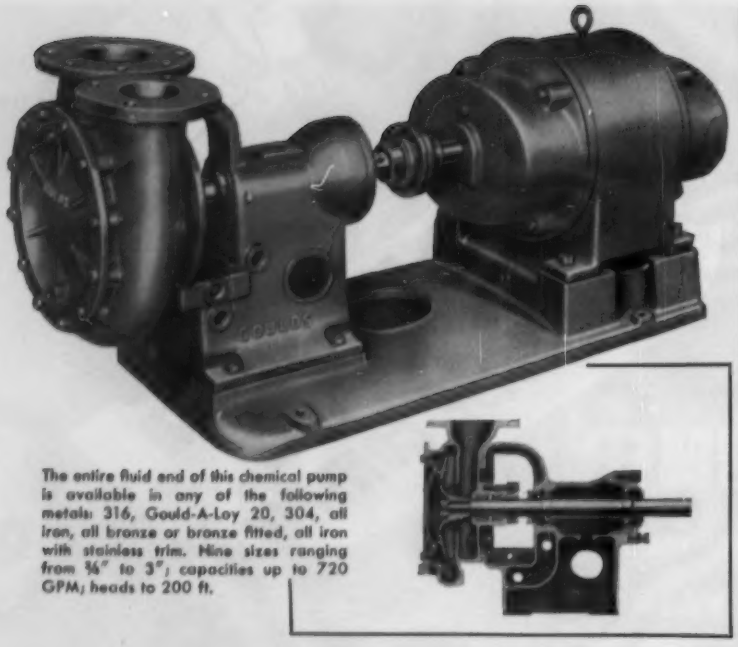

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More TECHNICAL BRIEFS

Begins on page 162

pensive methods will be required if atomic energy is to favorably compete with other fuels.

Anticipating this situation, AEC has placed research and development contracts with universities, private industry, the National laboratories and other federal agencies. Their task is to evaluate various waste-disposal methods and particularly the extent to which the ground, surface waterways and air may be used to store, shield, dilute and disperse radioactive wastes. *ASME paper no. 54-A-72.*

Optimum heat transfer for minimum thermal stress in nuclear-reactor shells. *By Professor F P Durham, University of Colorado.*

This paper presents a method for determining heat-transfer rates and thermal stresses from gamma-ray energy absorption of nuclear-reactor shells for plane geometries. Criteria for minimizing thermal stresses are developed, along with corresponding external cooling rates necessary to minimize thermal stresses.

Design charts are presented for rapid determination of approximate thermal stresses and heat-transfer rates. Numerical examples show use of the charts. *ASME paper no. 54-A-126.*

Feedwater treatment

Chemical treatments for corrosion control. *By Sheppard Powell and Lewis von Lossberg of Sheppard T Powell, Consulting Chemical Engineers.*

In central-station practice today, use of amines is one of several refinements to improve operation and protect metal in the system. Of various volatile amines, morpholine is favored for pH and corrosion control in the steam-water cycle. It is reported to have a more satisfactory ratio of distribution between vapor and liquid phases than ammonia or some other amines used for this purpose.

Feed rate for morpholine is less than for either ammonia or cyclohexylamine to maintain required pH of the condensate, especially the first-formed condensate in the turbine. There are other volatile amines, such as diethanolamine and triethanolamine, that have favorable distribution ratios. Unfortunately, these materials attack copper.

Waxy amines that form a protective film over the entire steam-distribution and condensate-collecting system have been used to some extent during the

Directions for ordering papers on p 260

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More TECHNICAL BRIEFS

Begins on page 162

last four or five years. Their application is being extended to many plants. This treatment seems to give favorable results in low-pressure steam-generating systems. *ASME paper no. 54-A-133.*

Hydrazine as an oxygen scavenger—a progress report on tests at Springdale Station. *By M D Baker, West Penn Power Co, and V M Marcy, Hall Laboratories, Inc.*

When hydrazine is used as an oxygen scavenger in a utility boiler, it should be fed continuously at a point after the deaerating heater. Intermittent feed is not advisable because of appreciable decomposition of the excess in a short time. Subsequently, the boiler may be deficient in hydrazine before the next slug of chemical is fed.

Test results indicate that minimum reserve of hydrazine in boiler water should be about 0.005 ppm. Lower concentrations may actually represent a deficiency in hydrazine, unless particular care is taken during the analysis.

A greater margin of safety is needed when the sample is not clear or colorless. When color or turbidity is present in the sample, minimum hydrazine content should be greater than 0.005 ppm. *ASME paper no. 54-A-261.*

Directions for ordering papers on p 260

Hydrazine for boiler feedwater treatment. *By Richard G Harshman and Eric R Woodward, Olin Mathieson Chemical Corp.*

Several central power stations in the U.S. are successfully using hydrazine as an oxygen scavenger in boiler feedwater treatment for boilers operating from 450 to 2500-psig drum pressure. Others plan to do so in the near future.

Hydrazine used in these stations confirms that it can reduce corrosion caused by dissolved oxygen without undesirable effects on boiler operation. Maintenance of a hydrazine residual in the water

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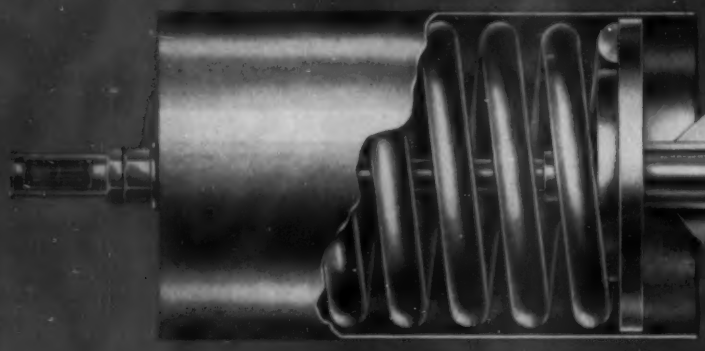

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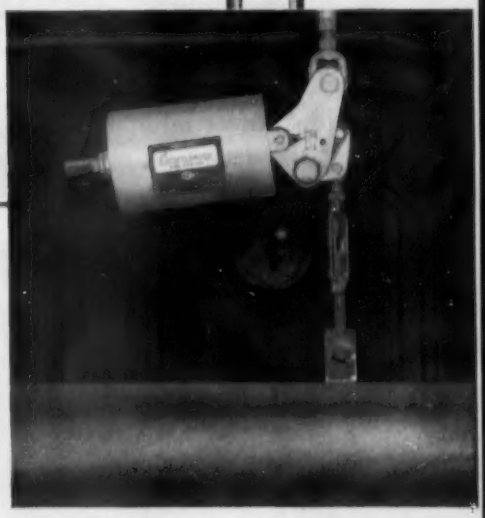
The Counterpoise Hanger is a spring-actuated counterbalance. An ingenious system of linkage transforms the varying force of the spring in an accurate mathematical ratio to produce a load supporting effort of constant value throughout the entire range of expansion travel.

The design permits great flexibility of installation and saves valuable space in congested areas. All parts are ruggedly made and have a high safety factor, yet excess weight and oversize physical dimensions have been avoided to hold space and structural load requirements to a minimum.

The Navco Counterpoise Hanger is available in 16 different frame sizes with load capacities ranging from 200 to 16,000 pounds and expansion travels up to 12 inches. For detailed information on how you can get dependable support with this unique hanger, write today for our 12-page illustrated bulletin #153.



Note above how the flexible top connection permits the hanger assembly to fall in line with the direction of the load pull, so that horizontal travel of the piping has no appreciable effect on the hanger operation. The unit may be positioned at any angle. This affords flexibility in installations where close clearances are a factor.

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FIG. 17-28
Cylinder

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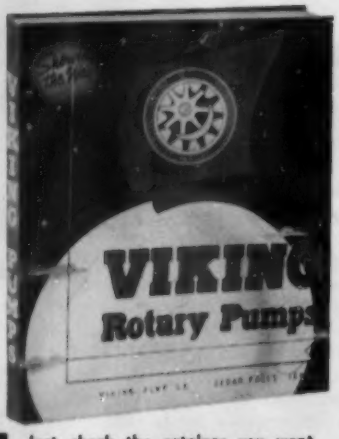

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More TECHNICAL BRIEFS

Begins on page 162

protects boiler against occasional increases in dissolved oxygen content that occur with variations in operating conditions. Hydrazine does not interfere with normal control of boiler-water pH, nor does it contribute to total solids content of water.

Easy to apply and control, a start has been made in using hydrazine in industrial boilers. Early results indicate its use will probably increase in this field. *ASME paper no. 54-A-124.*

Chemical deaeration of boiler water—Use of hydrazine compounds. *By J Leicester, Admiralty Materials Lab.*

This paper describes preliminary stages in an experimental study of reaction rates of the hydrazine-oxygen system. The work is continuing along four main lines—a bench-scale study of the mechanism of and factors influencing reaction, an investigation of reaction rates in a static autoclave system, study of reaction rates in a pilot-plant high-pressure boiler, and a series of full-scale boiler trials.

Simple reaction between hydrazine and oxygen has been shown to be far more complex than was at first thought. Perhaps the most important conclusion is that even in dilute solutions this can proceed as a surface reaction.

Experiments serve to indicate that at present it does not appear possible to predict efficiency of the reaction for a universal boiler application. To achieve the desired result some form of reaction catalyst may have to be developed. *ASME paper no. 54-A-123.*

Steam power

A power plant report to management. *By Stanley A Nelson, Deere and Co.*

How many engineers prepare an annual report to their company's management on operation of their power plants and consumption and cost of utilities? Those who do not probably wonder why they should since their plant produces all the steam, electricity, compressed air, refrigeration, or other services needed.

Perhaps this question can best be answered by asking four other questions and replying to them.

1. Why keep records and make reports?—Records and reports are a means of knowing how well operations are being carried on and what costs of various services and utilities are. They are a means of transmitting information from one person to another and

Directions for ordering papers on p 260

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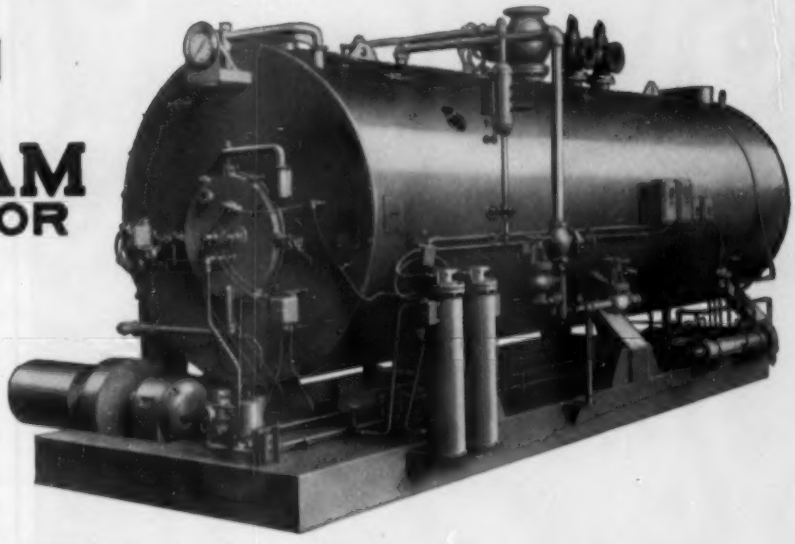

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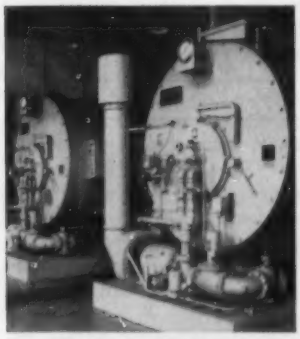

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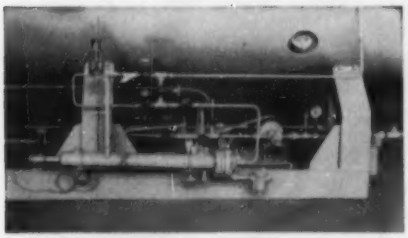
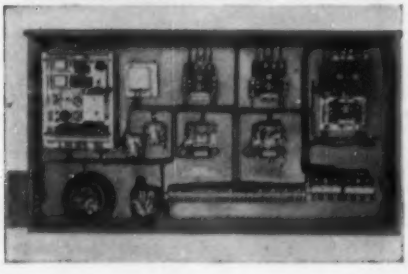


AMPLE ROOM

underneath for servicing auxiliary equipment. Control panel at eye level.



AUTOMATIC

operation, fully safeguarded, is provided by factory installed and tested control system.

SAVINGS IN FIRST COST!

Your purchase price includes complete unit — no hidden "extras" to buy later on!

SAVINGS AT INSTALLATIONS

Just set on level concrete floor, connect to service lines and breeching. Nothing to assemble. No brick work required.

SAVINGS IN OPERATION

A minimum of supervision — lower manhour requirements for maintenance — easily replaced inexpensive plastic refractories — 80% thermal efficiency.

Write for bulletin today!

AMES IRON WORKS, INC.
Oswego, N. Y., Box H-35

Gentlemen:

Please send me further information on AMESTEAM GENERATORS and name of nearest representative.

NAME.....

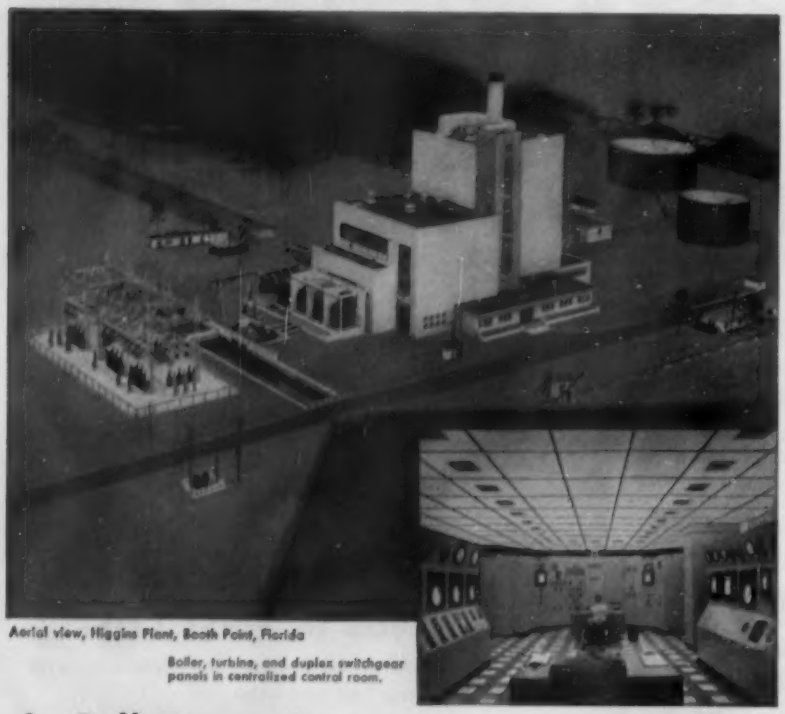
COMPANY.....

ADDRESS.....

AMES IRON WORKS INC.

BOX H-35 OSWEGO, N. Y.

From an impressive list of power projects successfully designed, engineered, and constructed by The Kuljian Corporation, comes a rewarding example of meticulous planning that paid off in remarkable savings in time, money, and an early accumulation of profits for the client.



Aerial view, Higgins Plant, Booth Point, Florida

Boiler, turbine, and duplex switchgear panels in centralized control room.

In Full Operation . . .

6 MONTHS AHEAD OF SCHEDULE!

When Florida Power Corporation decided to expand its generating facilities by the addition of the 132,000 KW Higgins Plant, work progressed so rapidly that installation of the first of three planned 44,000 KW units was completed 6 MONTHS AHEAD OF SCHEDULE . . . giving the client an urgently needed head start in meeting demands of industrial, commercial, and residential customers.

During all stages of the project . . . from determination of site location through initial operation of the first unit . . . Kuljian engineers worked with such exacting detail in design-engineering, material selection, working drawings, specifications, procurement, scheduling deliveries of material and equipment, and supervision of construction, that substantial savings were gained by Florida Power Corporation.

No matter what *your* problem is, if you are planning a steam, hydro, or diesel power plant . . . or expansion of your present facilities . . . Kuljian's wealth of practical experience can help you find the quick, economical solution to fit your specific needs. If you write or call, one of our engineers will be glad to explain how the Kuljian System has worked for others . . . *how it can work for you.*

The Kuljian Corporation

25th YEAR

engineers • constructors

1200 North Broad Street • Philadelphia 21, Penna.

MEXICO CITY • CARACAS • BOGOTA • MADRID • ATHENS • BEIRUT • TOKYO • CALCUTTA • RANGOON

More TECHNICAL BRIEFS

Begins on page 162

serve as a proof to the person and his employer that he is doing a good job.

2. What should go into reports?—Only the minimum information that is necessary for guiding operation and maintenance of a power plant or using utilities to best advantage should be included. Records and reports should be concise and useful. Remember an executive's time is valuable.

3. When should records and reports be available?—In order to be of most value in guiding operations, records and reports should be available as soon as possible after the data is taken. Otherwise, reports will only serve as historical data.

4. What should be done with them?—Train people to know what recorded data means and what they can do to correct poor operating conditions noted thereon. Engineers should study the results to determine what economies can be effected by careful operation of equipment or by installation of new or modernized equipment. Remember that management is primarily interested in getting the most for every dollar spent. *AISE paper; no number.*

Directions for ordering papers on p 260

New power, steam and blowing installations at Ohio Steel Works. *By J P Katzenmeyer, U. S. Steel Corp.*

At the close of World War II, Ohio Steel Works found itself with power, steam, and blowing facilities of antiquated vintage that, through continued use at peak capacities, had deteriorated to the extent that immediate replacement was necessary to avoid curtailment of production. Actual rate of deterioration was so rapid during the construction period, that it was often questionable whether new facilities would be in operation before the old facilities became inoperative.

Several temporary measures were utilized in an attempt to alleviate loss of production, while a plan for replacement in function of worn-out equipment could be worked out and executed. These temporary measures included transfer of a turbo-blower from Edgar Thomson Works to permit a reduced rate of operations on old gas and steam blowing engines; transfer of two frequency changers from South Works to relieve a power shortage by purchasing power; and installation of a 14-in. steam line, parallel to an existing 20-in. line, to reduce pressure loss and permit a higher throttle pressure on existing turbo-generators, thus increasing their kw output and permitting decreased

(*Continued on page* 260)

Refinery proving ground confirms superiority of Triple-Zone Gilsulate for hot underground pipes

"...pipes looked absolutely new...insulating efficiency equal to or better than any other...cost of the GILSULATE *system has been appreciably lower."*

—R. W. AYER, Chief Engineer, Salt Lake Refining Company

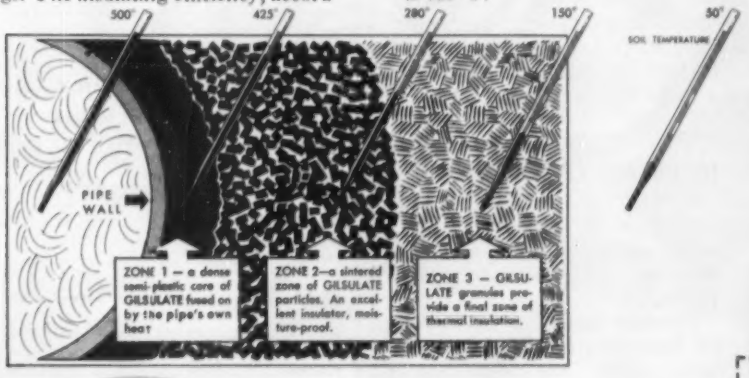
Salt Lake Refining Company confirms the findings of hundreds of GILSULATE® installations throughout the country: this *triple-zone insulation* succeeds where others have not fulfilled all operating conditions—*and at lowest cost per installed linear foot.*

Research excavation of the initial GILSULATE installation at Salt Lake Refining Company, after 14 months of service, proved to their engineering and maintenance staff that this new insulation functioned at peak efficiency. Both lines—one of steam, one of water—were in excellent condition, with no evidence of pitting or scaling. Additional GILSULATE installations have been made since by the company for utility services and for road crossings. The insulating efficiency, according to their chief engineer, is "equal to or better" than any of the various other types of installations—and "at a cost that is appreciably lower."

Investigate the values of this easily installed, low-cost insulation yourself. Use the coupon below for complete information, or see your local GILSULATE distributor.

FACTS ABOUT GILSULATE

1. *Easy to use*—just pour, tamp and backfill... pipe heat does the rest.
2. *Forms 3 zones of protection* against heat loss and all commonly encountered hazards to hot buried pipes.
3. *Needs no* sleeves or mechanical sheaths: no mixing or special handling.
4. *Needs only* normal pipe spacing: for multiple pipe or cramped conditions.
5. *3 types* for varying temperature ranges up to 520° F.


500°
425°
280°
150°
50°
SOIL TEMPERATURE
PIPE WALL
ZONE 1 — a dense semi-plastic core of GILSULATE fused on by the pipe's own heat
ZONE 2—a sintered zone of GILSULATE particles. An excellent insulator, moisture-proof.
ZONE 3 — GILSULATE granules provide a final zone of thermal insulation.

Installing new GILSULATE *system is simply a matter of pouring (note metal forms to conserve material), tamping down...and backfilling.*

THE TRIPLE-ZONE INSULATION FOR LIFETIME PROTECTION OF HOT UNDERGROUND PIPES

GILSULATE®

AMERICAN GILSONITE COMPANY, SALT LAKE CITY 1, UTAH
Affiliate of Barber Oil Corp. & Standard Oil Co. of California

American Gilsonite Co.
134-P West Broadway, Salt Lake City 1, Utah
or
1145 East Jersey St., Elizabeth, N. J.

Send me more information on GILSULATE Insulation

NAME .....

TITLE .....

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P

MOGUL
A Name You Can Rely On
MOGUL — EVER CLEAN BOILER PROCESS — eliminates pitting, congestion, foaming, priming and oil troubles in high pressure boilers.
MOGUL — RUST ERADICATOR — for cooling towers, air conditioning, water supply systems — "wherever water flows".
MOGUL — ALGICIDE — eliminates algae and prevents further growth.
MOGUL — Service is based on specific analysis of YOUR particular water condition, recommended formula — and regular inspection by the MOGUL Service Man.
MOGUL — Guarantees results.
MOGUL's Guarantee is backed by a bond issued by The Fidelity and Casualty Company of New York.
MOGUL — Products and service are backed by 40 years successful experience.
Ask for information on regular Mogul Service for your plant.
The North American
MOGUL
PRODUCTS COMPANY
Cleveland 13, Ohio

More TECHNICAL BRIEFS

Begins on page 162

loading of the deteriorated gas engines.

Final replacement of worn-out facilities included three turbo-blowers, cooling towers, complete switchgear for all generators and distribution circuits, two high-pressure blast-furnace-gas-fired boilers with blast-furnace gas precipitators, and a topping turbo-generator that exhausts into the existing plant steam system.

This paper covers a complete description of the problem, temporary solutions, final solution, new equipment installed, and interesting sidelights in connection with the many problems involved when new equipment is installed in an existing plant without loss of production. *AISE paper; no number.*

Turbine operating and outage data for 1953. *Edison Electric Institute.*

This report presents operating and outage data for 1953 on 404 horizontal-type turbines operating at 800 psi and higher, rated at 10,000 kw superimposed, 20,000 kw condensing, or larger. Also included are comparative data for the 10-year interval 1944-1953 for turbines of the above sizes and pressures.

Outage hours due to turbines was 4.11% of the 3,502,838 period hours reviewed, generators 1.02%, condensers 0.24%, other causes 1.46%. The average number of idle periods per turbine was 21.

Specific causes under each major heading are tabulated in terms of hours, number of machines affected and outage hours per machine. Total average average outage hours per unit was 661 in 1944, 592 in 1953. *EEI publication no. 54-15.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Society of Mechanical Engineers. Identified by initions ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

Association of Iron and Steel Engineers. Identified by initials AISE and to be published in their entirety by AISE, Empire Building, Pittsburgh, Pennsylvania.

Edison Electric Institute. Identified by initials EEI and obtainable through purchase from EEI, 420 Lexington Ave, New York 17, New York.

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Mail in the coupon if you plan to move. And please fill it in as completely as possible.

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Taylor Flow Transmitter gives you MANY OUTSTANDING ADVANTAGES

THE Taylor TRANSAIRE* Differential Pressure Transmitter gives you many very desirable features, in addition to the inherent advantages of a force-balance instrument such as: mercuryless; simplified installation and piping; seal pot elimination; lightweight, etc. These extra features, indicated on the picture below, mean—

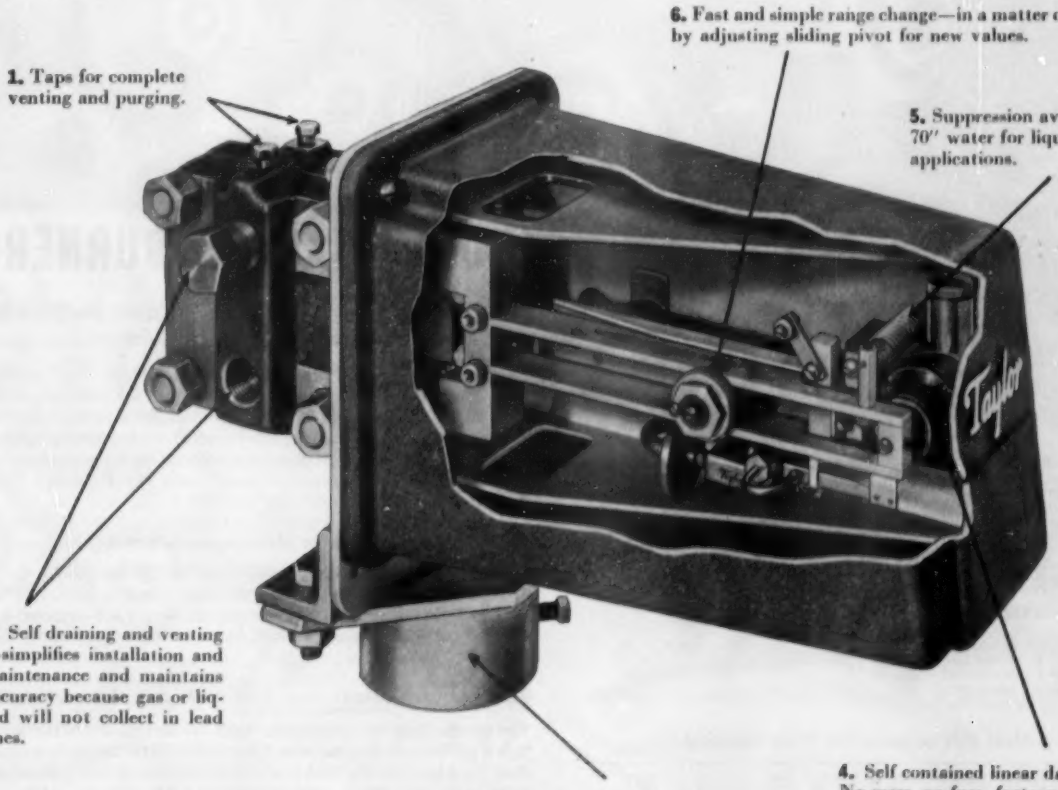
- ☆ **Increased flexibility**
- ☆ **Easier maintenance**
- ☆ **Rugged dependability**
- ☆ **Reliable accuracy**

About half of your instrument problems are connected with flow. Here is an instrument that will solve them—and many others requiring differential pressure measurement and transmission.

♦ ♦ ♦

Call your Taylor Field Engineer for full information, or write for **Bulletin 98097.** Taylor Instrument Companies, Rochester, N.Y.; Toronto, Canada.

*Reg. U.S. Pat. Off.



1. Taps for complete venting and purging.

2. Self draining and venting—simplifies installation and maintenance and maintains accuracy because gas or liquid will not collect in lead lines.

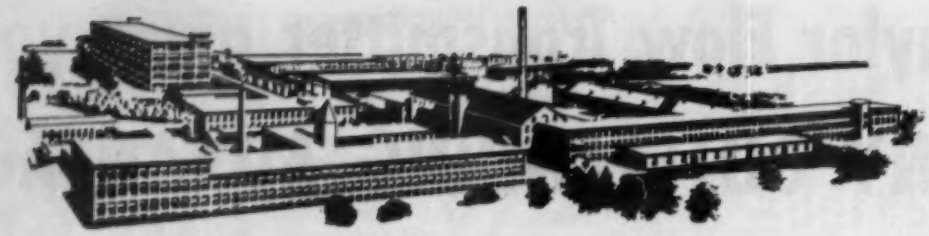
3. Easy mounting—top, side or bottom.

4. Self contained linear dampener. No mess, no fuss, factory filled.

5. Suppression available to 70" water for liquid level applications.

6. Fast and simple range change—in a matter of minutes by adjusting sliding pivot for new values.

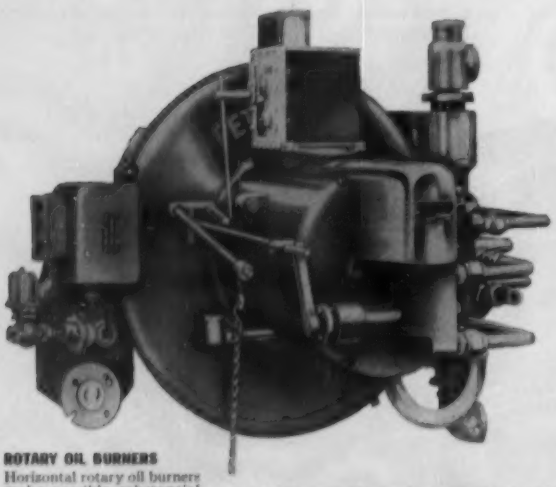
Taylor Instruments MEAN ACCURACY FIRST



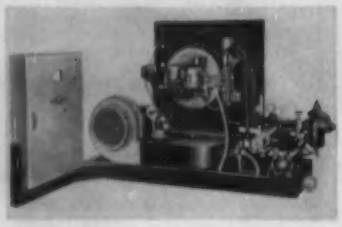
DAVIS & FURBER MACHINE COMPANY, NORTH ANDOVER, MASS.

SAVED $12,000

on fuel the first year with



ROTARY OIL BURNERS
Horizontal rotary oil burners make possible substantial fuel savings by burning the low-cost heavy fuel oils with complete dependability. Models for every industrial need. Capacities up to 600 boiler horsepower.



COMPLETE PACKAGED UNIT
A complete forced draft combustion system with all parts factory-assembled and tested. Saves installation time and cost, gives top performance and fuel economy.

PETRO

T. M. REG. U. S. PAT. OFF.

INDUSTRIAL OIL BURNERS

"The changeover to Petro oil firing paid for itself the first year," says Forbes Rockwell of Davis & Furber

PETRO oil burners do *two* jobs in this huge plant. They produce steam for heat and generate the electric power for plant operation. "We consider it nothing short of a minor miracle the way your dealer's engineering department came in here and changed us over to oil in the middle of winter without causing us to curtail the least bit in either power or heat," says Mr. Rockwell. Petro oil burners can save money for you too.

PETRO preheats oil for steady, sure firing

Cold oil is sluggish, starts slowly, and burns irregularly so the makers of Petro adopted the "thermal viscosity principle" of *preheating oil* to an efficient temperature before it is injected into the firebox. This makes possible fast starting, steady firing, and lower fuel costs.

PETRO burns lower cost fuel with complete reliability

The pre-heating of oil enables Petro owners to burn the heavy fuel oils (Nos. 5 and 6), which average 8% richer in heat value than light burner oils, and cost less per gallon. Petro burners are completely automatic, and accurately take care of fluctuating load requirements.

PETRO is adaptable to any boiler room

Petro industrial oil burners are designed and built to *modernize* the firing of your present boilers. The flame is adjustable to any firebox, and the installation is adaptable to any boiler room layout. This means that you save substantially on initial installation costs, and more money every day on fuel and labor costs. Mail coupon or write for free catalog and information.

Mail this coupon for Free Catalog

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3216 West 106th St., Cleveland 11, Ohio
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Please send the 20-page illustrated Petro catalog.

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WALWORTH

WALSEAL® VALVES AND FITTINGS

Better because . . . **There's no guesswork when a silver-brazed joint is made with a Walseal fitting. Sil-Fos alloy, which appears as a fillet at the face of a Walseal joint, comes from rings which have been factory-inserted in the end connections of Walseal fittings. The bright silver alloy fillet that you can see assures full penetration of alloy for a permanently leakproof joint.**

Cutaway view of a Walseal Tee showing: factory-inserted ring of silver brazing alloy; fillet of silver brazing alloy that appears upon completion of Walseal joint; cutaway view of the completed joint showing that silver brazing alloy has flowed in both directions from the factory-inserted ring.

Walseal is a registered trade mark identifying bronze valves and fittings manufactured by the Walworth Company. Walseal products have factory-inserted rings of silver brazing alloy in threadless ports. Walseal joints can be made only with Walseal valves and fittings.

If you're piping water, oil, steam, air, oxygen, nitrogen, helium or other industrial gases or refrigerants through brass, copper, or copper-nickel pipe, you'll want to investigate Walseal – available in complete lines of bronze valves and fittings in four distinct pressure ranges – from 0 to 5000 psi. working pressure*. Your copy of Circular 115 will be sent on request . . . see your near-by Walworth Distributor today, or write to: Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

*Walseal fittings and valves are being used at sub-zero temperatures as low as —350 F.

Make it "a one-piece pipeline" with WALSEAL

SEE OUR CATALOG IN SWEET'S

WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Jones & Laughlin *uses many*

Fuller Rotary Compressors

Like many other steel producers and fabricators, from the East to the West Coast, Jones & Laughlin Steel Corporation has purchased and uses many Fuller Rotaries in its various mills. Illustrated above is a Fuller Rotary Two-stage Compressor, having a capacity of 1660 c.f.m. 120-lb. pressure, installed in the P-1-10″ bar mill of the Pittsburgh Works Division.

Endurance, plus efficiency and maintained capacity, flow of air without pulsations, elimination of vibration, are results of the rotary principle employed in the design of the Fuller Compressor. They can be placed on comparatively light foundations, on balconies or upper floors to save valuable floor space and shorten distribution lines. Employing a minimum of moving parts—rotor, bearings, blades—greatly reduces maintenance and eliminates adjustments entirely.

The cylinders of a Fuller two-stage machine are at ground level, mounted on a common base plate, and are connected by a flexible coupling. Installation is very simple, the motor being lined up to the coupling on the shaft extending from the low-pressure cylinder. This arrangement simplifies motor maintenance work as compared with many other types of machines.

Due to extremely low inertia and WR^2, Fuller compressors, which operate in speed ranges of 600 to 1750 r.p.m., according to size, and are directly coupled to the motor, may be installed with either a general purpose or a normal torque synchronous motor, as dictated by size and the electrical requirements of the plant. Standard motors are available for all sizes of Fuller compressors in either squirrel cage or synchronous types.

For full information, write for Bulletin C-5A.

FULLER COMPANY, Catasauqua, Pa.

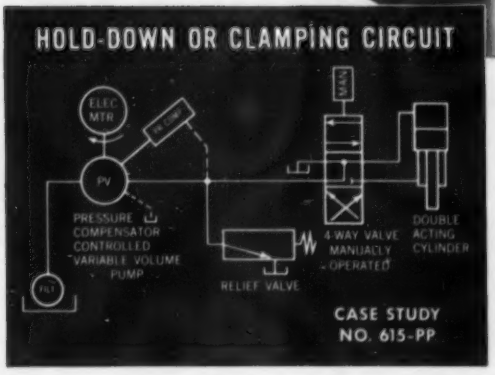
Chicago • San Francisco • Los Angeles • Seattle • Birmingham

C259
1292

Fuller

PIONEERS OF HIGH-EFFICIENCY VANE-TYPE ROTARY COMPRESSORS

5000 psi— continuously



Denison Axial Piston Pumps operate continuously at 5000 psi, deliver up to 35 gallons per minute

Few hydraulic pumps can operate at 5000 psi. And, if they can, it's for only a few seconds at 5000 psi. Not so with Denison Axial Piston Pumps. They deliver up to 35 gpm at 5000 psi . . . continuously. Yet they cost no more than many pumps with lower pressure ratings.

Three sizes deliver 10, 20 and 35 gpm. Available in constant or variable volume types . . . with handwheel, pressure-compensating, stem or cylinder volume controls. Mountings: Face, flange or foot.

The circuit shows a Denison Axial Piston Pump in a hold-down or clamping circuit. Write us for bulletins about Denison pumps.

DENISON Hydr**OIL**ics

PUMPS • MOTORS • CONTROLS • PRESSES

THE DENISON ENGINEERING COMPANY
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HOW TO BUY CONVEYOR BELTS

and get...
MORE USE PER DOLLAR
where
SPECIAL ENGINEERING
is needed

Look for a make of belt backed by experienced, specialized engineering service.

Selecting the right conveyor belt to solve a special problem begins with selecting the right representative . . . one who will take interest in your particular belt needs and refer your problems to his factory if engineering help is required. Where a company makes a wide selection of conveyor belts for many applications, the representative can often recommend a feature construction to meet your job requirements. Where your problem is unique, that company backs its field men with custom engineering and comes up with a recommendation to meet your specific operating conditions.

Choose the company that offers *complete* belt engineering service . . . the source of supply that maintains close contact between factory and field.

RAYBESTOS-MANHATTAN CONVEYOR BELT ENGINEERING

A leading steel mill, faced with handling hot sintered ore without an insulating layer of "fines", had numerous belt failures due to charring.

An R/M representative called in a factory engineer. A new custom-engineered R/M conveyor belt with special cover now saves hundreds of dollars a year at the mill.

and . . . where hot ash and clinker was wearing out a conveyor belt every month at a Michigan cement plant, an R/M field man was able to furnish a specially engineered Homocord Belt which has outlived the best previous belt four times over.

and . . . special, "chevron cleated" conveyor belt was developed by R/M, as a result of a field representative request, to replace a smooth surfaced belt unable to carry wet iron ore up a mine slope without costly spillage.

These are just a few of many instances where R/M engineering service has solved conveyor belt problems. In other cases, special job requirements have been met with R/M's exclusive constructions such as extra-flexible Ray-Man "F" . . . extra-cushioned Homocord for shock-loading . . . and Ray-Man Tension-Master for extra-high tensions and long lifts.

Let an R/M representative show you why R/M engineering makes R/M Conveyor Belts last much longer . . . give you "More Use per Dollar".

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

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Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
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The day J. B. learned about Ultra-Deionizers*

(*ELGIN-REFINITE'S, OF COURSE!)

Like a lot of other good engineers, J. B. had a favorite water conditioning system. He'd been coddling and nursing it along for years. Then came the day when he had to admit—with reluctance—that his poor old equipment just *couldn't* take care of the plant's exacting needs. And to make things worse, one fine morning, J. B.'s Old Reliable gave a grunt and just quit.

That was it. Operations at a standstill, people stewing all over the place, trucks hauling in distilled water to get things going again, the accounting department blowing its stack, everybody on J. B.'s neck—and J. B. fit to be tied.

Right about then, the afternoon mail brought an Elgin-Refinite catalog, and J. B. found out the details about Ultra-DeIonizers. First off, he discovered that he could be sure of water *purity:* deionized water contains less than *one ppm* solids—while even distilled water may contain as high as 10 ppm—and instead of the high water-treating costs he had been accustomed to with Old Reliable, J. B. found that deionized water could be produced for as little as 18 cents per thousand gallons.

After that, things got back in shape in a hurry. Elgin-Refinite's high-capacity Ultra-DeIonizer not only replaced Old Reliable, but there's plenty of capacity margin left over for plant expansion. If your present water conditioning system is costing you more than it should, or it is not delivering water sufficiently high in quality for most efficient operation, you'd better find out about the Ultra-DeIonizer, too. It produces water of highest chemical purity at an amazingly low cost. For complete information, ask for Bulletin 512.

For information about any of our other water conditioning equipment shown below, let us put the nearest Elgin-Refinite man in touch with you.

Elgin-Refinite • *Division of Elgin Softener Corp.* • 130 N. Grove Ave., Elgin, Ill.

Representatives in Principal Cities • In Canada: G. F. Sterne & Sons, Brantford

Elgin REFINITE SINCE 1908

Water Conditioning Since 1908

ION EXCHANGERS • FILTERS • DEAERATING HEATERS • DEALKALIZERS • DEGASITORS • LIME-COAGULATION

NO Reducing Valve Needed

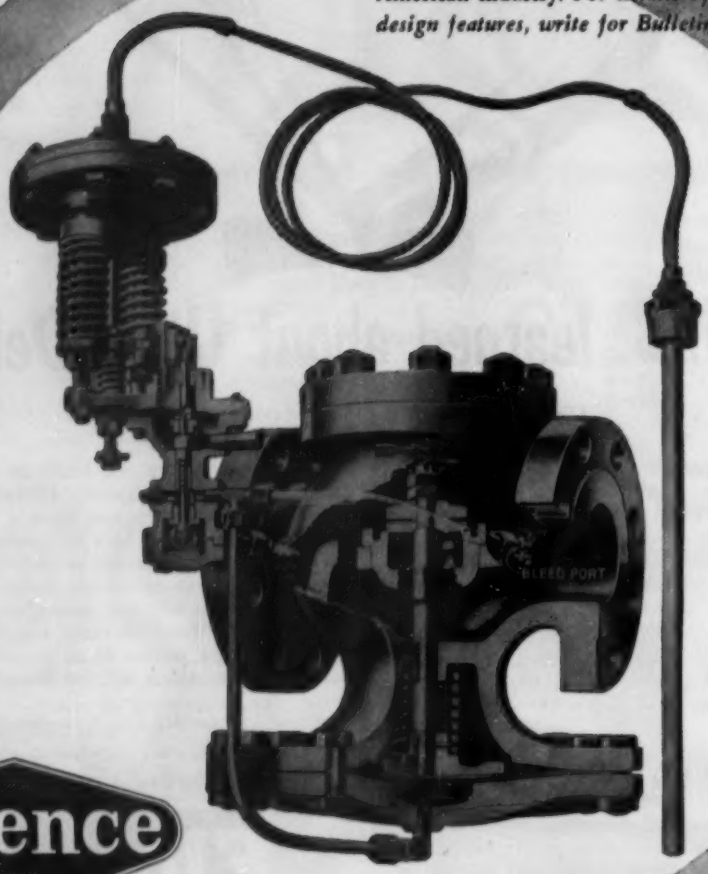
Here's real economy in temperature control.

Because Spence Temperature Regulators are designed to limit heater steam pressures to an adjustable maximum, the need for a separate reducing valve is completely eliminated.

The Spence Regulator takes steam directly from the boiler or high pressure line, reduces the pressure and regulates the flow as required to maintain a constant temperature output from the heater.

This means one relatively small combination pressure and temperature regulator replaces a reducing valve of the same size and a larger temperature regulator. Practically the entire cost of the large separate temperature regulator is saved. And, the total saving would also include the cost of a 3-valve by-pass along with all labor for installation.

This design feature is just one of the reasons for the thousands of Spence installations throughout American industry. *For details of other important design features, write for Bulletin T50.*

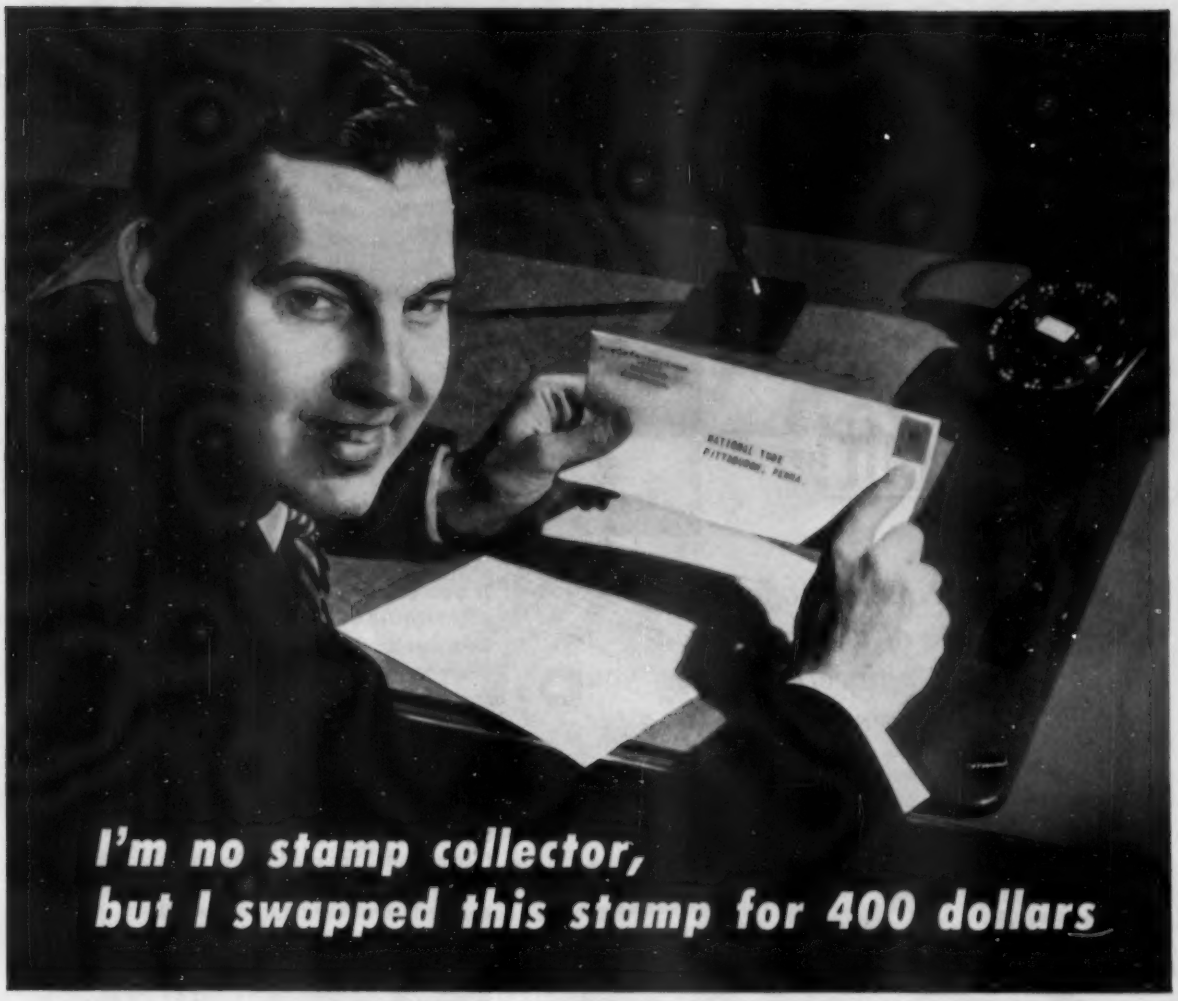


SPENCE
TYPE ET150
Temperature
Regulator

Spence

SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

SE-131



I'm no stamp collector, but I swapped this stamp for 400 dollars

I don't know anything about rare old stamps. The stamp I put on this letter was an ordinary three-center, but it proved to be just as valuable as many a collector's item.

WALLS WITHOUT WELDS

Here's what happened:

We retubed a large section of the plant recently with high pressure steam piping. I worked out a tubing analysis to handle the higher temperatures and pressures we planned to use; a good safe analysis—high alloy steel in a heavyweight seamless grade.

However, before I ordered the pipe, I thought I'd take advantage of National Tube's free advisory service, so I wrote a letter asking for *their* tubing recommendation. That's when I swapped my three-cent stamp for 400 dollars.

National Tube's recommendation turned out to be a less expensive tubing, yet it was the *exact* analysis for the job. My analysis was a little too good—really more than the installation warranted. When the costs were figured, the National Tube recommendation was 400 dollars less than mine—a direct savings for our plant. The advice had cost me just three cents. Not a bad investment, was it?

When you are in the market for pipe and tubing, call or write National Tube. You'll get the right analysis for the job, every time—at the lowest cost to you.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

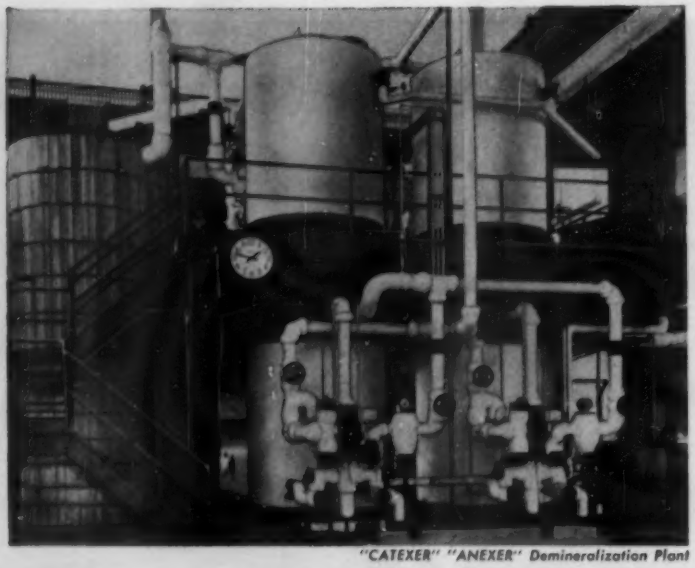
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL *Seamless* PIPE AND TUBES

UNITED STATES STEEL

Your boiler feedwater problem is different!



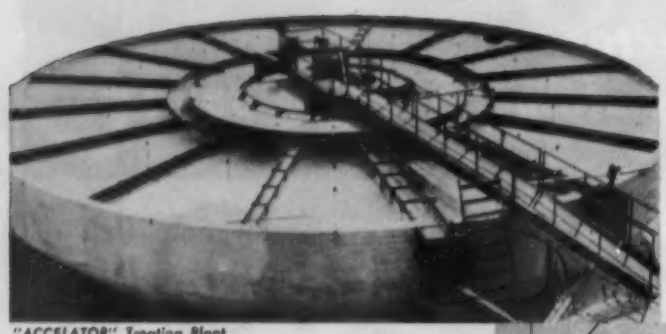
"CATEXER" "ANEXER" Demineralization Plant

That is why INFILCO offers you a complete range of water treating plants custom engineered to meet your particular requirements. For example–

If you use high pressure boilers, you might require a CATEXER® ANEXER® Demineralization Plant. These plants give you improved make-up quality, adequate supply regardless of station electrical load, reduced overall operating costs, and lowered maintenance costs and labor expense.

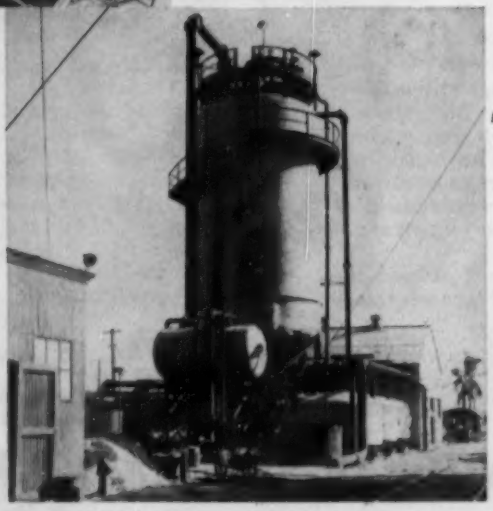
For low pressure boilers, the ACCELATOR® Treating Plant offers a most economical means of treating feedwater. It is also frequently recommended for pre-treating make-up water for high pressure boilers. "ACCELATOR" Clarifiers and Softeners have a proven record of flexibility and ease of operation.

Feedwater for intermediate boiler pressures can often be treated by INFILCO Hot Process Softeners. These softeners are noted for their accurate treatment control and superior performance. They are often used in combination with Hot Process Zeolite Softeners.



"ACCELATOR" Treating Plant

Whatever your feedwater problem, you can depend on the complete engineering know-how and many years experience that have made INFILCO a leader in this field. Why not submit your problem today. INFILCO engineers will suggest a practical solution. Write for information.



Hot Process Softener

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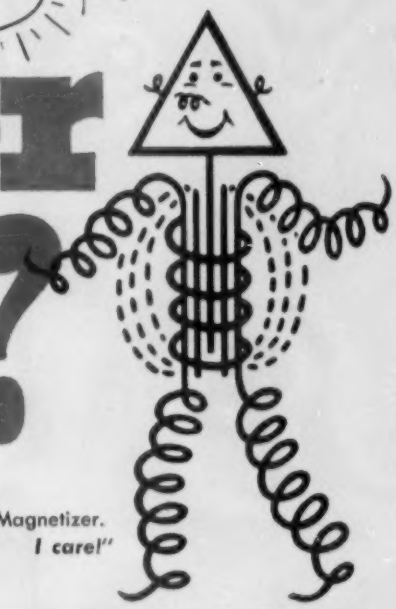
The one company offering engineered equipment for all types of water and waste processing—coagulation, precipitation, sedimentation, flotation, filtration, ion exchange and biological treatment.

INFILCO INC. 917 S. Campbell Ave., Tucson, Arizona
Field offices in principal cities in North America 5527

COULD YOU LEARN TO CARE ABOUT...

power factor?



"I'm Mortimer Magnetizer. I care!"

"Mortimer Magnetizer is my name. Nobody has ever actually seen me, but anywhere electric motors are being used I get a powerful lot of work done!

"What I do is really simple—I set up the magnetic fields in the motors, and until I get going nothing much happens in your plant.

"Now, that's all well and good. I like my work. But it's the *Power Factor* business that bothers me. Because of *low* power factor in many plants, I get a lot of blame that's really not my fault. Honestly.

"You see, many plants use a goodly number of induction motors, and I like to magnetize them . . . they're hard workers. But unfortunately the reactive kva which I must have to magnetize is not produced by an induction motor. Instead, I must draw it from the main power system, and in a plant full of induction motors I can really 'overdraw' my account!

"This means the incoming power system must carry *two* things—*kilowatts* for useful work by the motors, and plenty of *reactive kva* for my magnetizing. The more of the latter, the less of the former, and brother, that's *low* power factor. It's expensive, because the 'deadhead' reactive kva can't do the work you want done, and yet you pay for it.

"What's the answer? Why, it's simple. The answer is Synchronous Motors. Use them wherever possible! They not only supply their own reactive kva for my magnetizing, but they can even be designed to supply extra or 'leading' reactive kva to offset kva demands elsewhere on the line.

"Now here's Utopia for me! When you use Synchronous Motors to supply reactive kva, you can reach a glorious state called UNITY, in which no costly reactive kva is required from the power system. Brother, that's *high* power factor, and that's how I work best!

"Where to go for Synchronous Motors and expert help on their applications? Go to E-M, of course. E-M pioneered the use of Synchronous Motors . . . E-M engineers know them and their applications from A to Z. And, naturally, Power Factor Improvement is a specialty at E-M.

"They've put all the answers into the practical, informative book shown at left. And ask your E-M sales engineer for helpful suggestions. He knows me, I know him. We work well together!"

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Protection of individual circuits against harmful overloads and other faults pays off in a minimum of downtime: production is steadier, profits higher. Protection of personnel pays off over and above the human values: increases production, lowers insurance rates. The safety offered by I-T-E Urelites is complemented by simplicity of design, ease of operation, economy of maintenance.

I-T-E Urelites are available through your local I-T-E distributor in four types of enclosures: general purpose, panel-mounted, weatherproof, and dustproof; and with auxiliary and tripping devices to fit specific applications. Ask him for literature or, if more convenient, write I-T-E Circuit Breaker Company, 19th and Hamilton Sts., Philadelphia 30, Pa.

I-T-E Type KA. 15,000 amp interrupting capacity. 15-225 amp continuous. 600 v a-c, 250 v d-c. 2, 3 and 4 pole.

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I-T-E CIRCUIT BREAKER COMPANY

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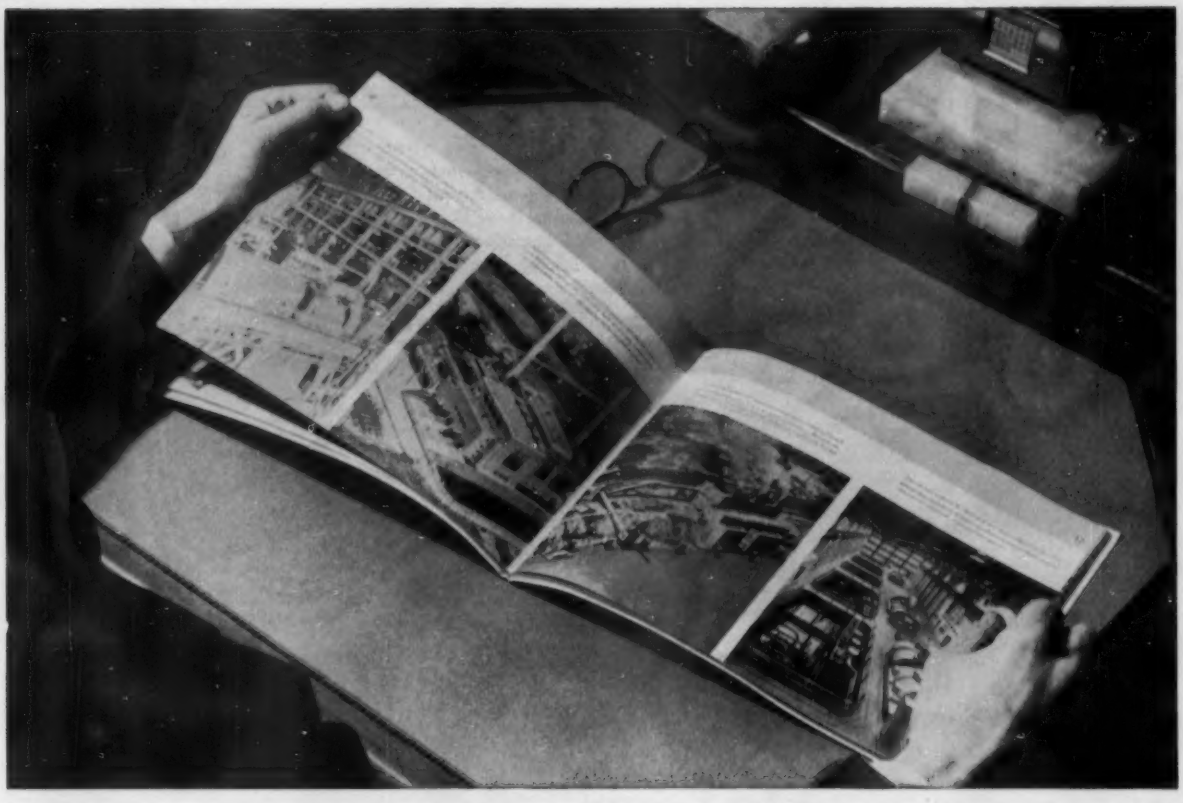

Let this BOOK show you how Dravo's Construction Department can work for you

Whether it's the installation of a pump or the furnishing and installing of a water and waste treatment plant . . . the fabrication and erection of piping . . . the construction of oil or gas pumping stations or the construction of a power plant . . . it's a job Dravo's Construction Department can do for you. Dravo's range of engineering construction activities is described in this new 45-page book, filled with photographs of many typical examples of Dravo-built installations throughout the United States.

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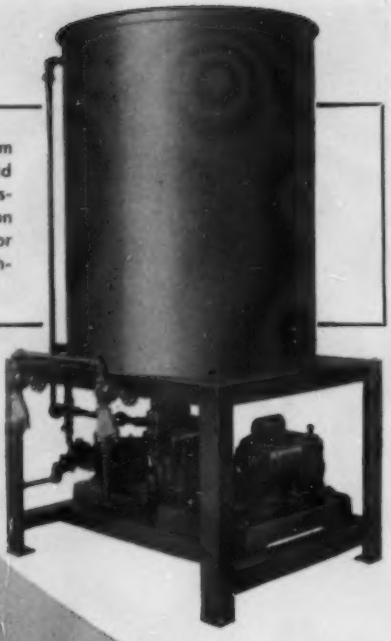
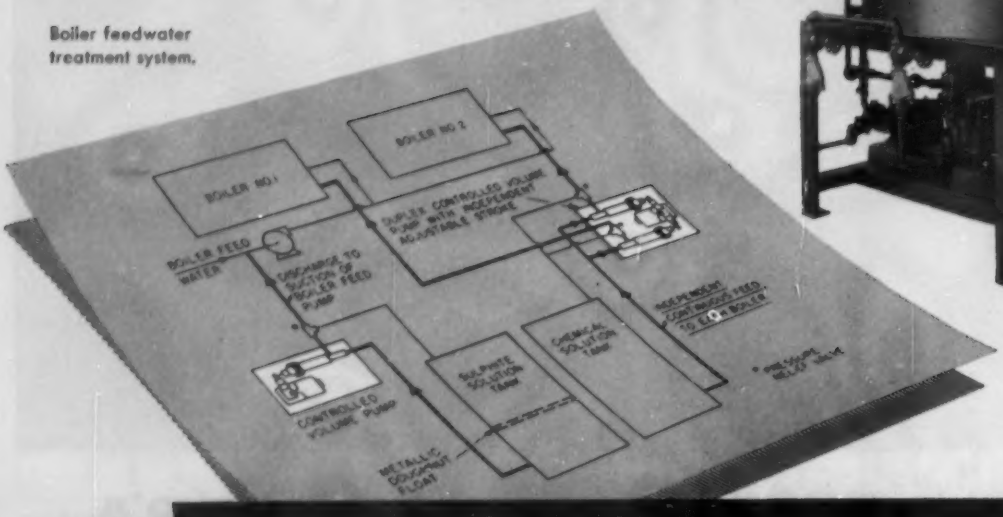


Boiler feedwater treatment system.



this flow-control approach

cuts cost of boiler water treatment . . . boosts boiler and turbine life

REDUCED chemical costs, increased boiler and turbine life . . . result when treating chemicals are *accurately* metered in boiler water treating systems.

This simple packaged system, for example, provides an economical solution to the continuous treatment of boiler feed water. A simplex Controlled Volume Pump injects sodium sulfite directly into the reservoir of the deaerating heater, thereby removing residual oxygen and preventing pitting of economizers and boiler feed pumps. A duplex Controlled Volume Pump meters phosphate directly to the boiler drum of each of two boilers, thereby removing dissolved minerals and preventing scale formation in boiler tubes.

Milton Roy engineers and fabricates complete packaged systems for the treatment of boiler feedwater, with all necessary piping, valves, and liquid level gauge. Agitators, dissolving baskets, instrumentation, and alarms can also be furnished, as desired.

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Write for technical information. Or, send your problem to Milton Roy Company, *Manufacturing Engineers*, 1300 East Mermaid Lane, Philadelphia 18, Pa.

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CONTROLLED VOLUME PUMPS

AT THE WORUMBO MFG. CO., coal is elevated from a truck hopper to storage silo at 25 tons per hour by a REDLER Conveyor-Elevator. This unit is self feeding and can pick up coal from either a truck hopper or small yard storage hopper. Closed REDLER system running under roadway and over stoker hoppers recovers coal from silo at 10-tons per hour.

They Save $50,000 a Year!

Four Stokers are fed by horizontal REDLER running above hoppers. Rack and pinion gates permit selection of hoppers to be filled. When last hopper is full, Tellevel control shuts off system. Note the clean, dustless appearance of the firing aisle, made possible by the sealed-in feature of REDLER Conveyors.

Modernization of the entire steam plant at Worumbo Mfg. Co., Lisbon Falls, Maine has cut coal consumption 21%, labor costs 60% for annual savings of $50,000. An important part of the labor savings is made possible by an S-A REDLER coal handling system. Operating automatically, this compact system moves coal within sealed casings to practically eliminate coal dust inside the plant. REDLER flexibility also solved a difficult location problem in the Worumbo plant since coal unloading and storage is separated from stokers by a roadway. Other REDLER advantages contributing to lower costs are reasonable first cost and low maintenance.

If dustless coal handling, low operating costs and location flexibility are requirements for a coal handling system in your plant, be sure to investigate S-A REDLERS. We'll be glad to send you full information. Just fill out and mail the coupon.

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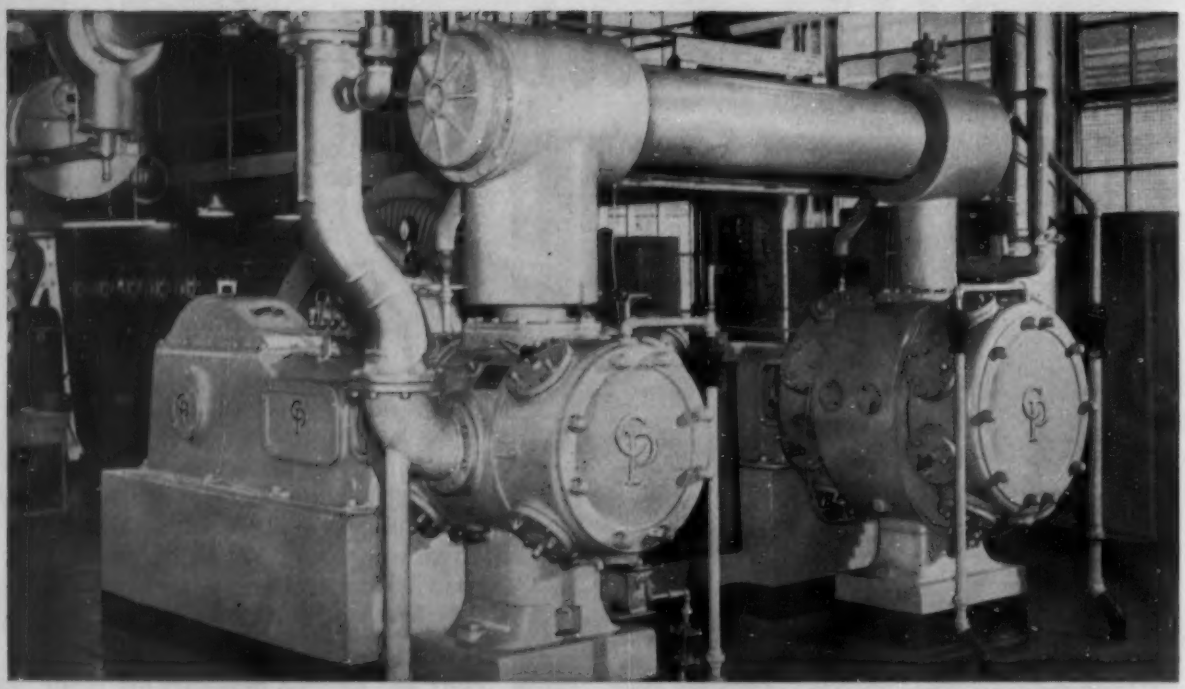
this trade mark . . .

key to compressor dependability



The dependability of CP's heavy-duty Class O-CE horizontal duplex compressors is reflected in repeat orders. Typical of these is one from a prominent electrical manufacturer: The first CP Compressor in this plant—300 HP size—was installed in 1935 . . . the second—rated 400 HP—was added in 1951. Both operate continuously, with remarkably low upkeep . . . and they should be "going strong" in 1975.

The long life, low upkeep and high efficiency of O-CE Compressors are due to their moderate ratings, Simplate Valves, completely effective and easy-to-clean intercoolers, and their roller main and crankpin bearings. Built in sizes up to 2,000 HP, they're available in single and multi-stage designs, steam and electric drives, for pressures up to 15,000 pounds. For details write *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, N. Y.*

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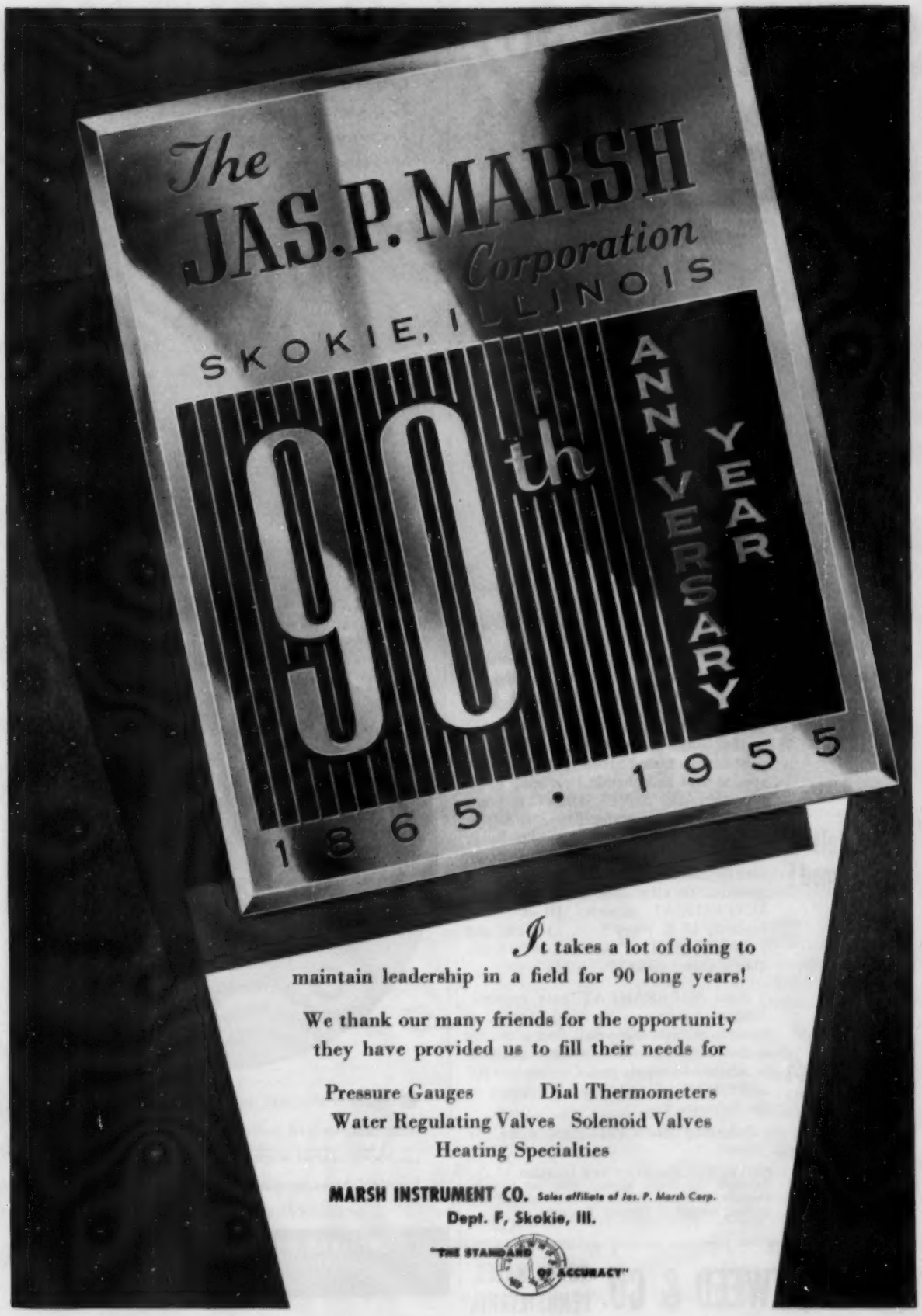

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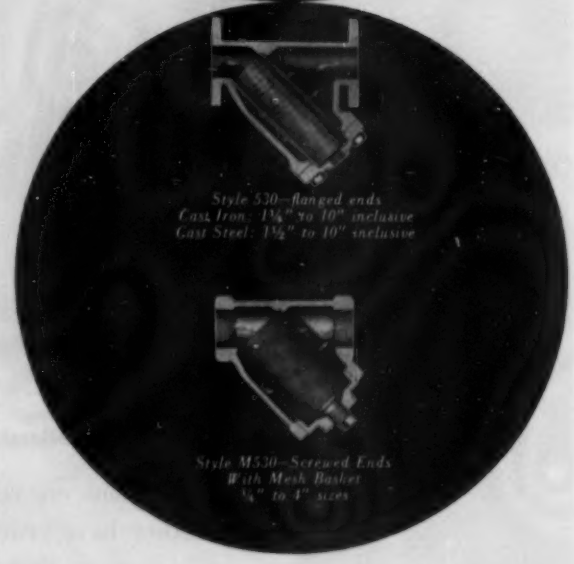
In the selection of protective strainer equipment for costly control and automatic trap installation ***McAlear offers the finest-widest line in the industrial field.***

Here's McAlear King Size Style 528 Strainer for hydraulic service . . . body, cast steel . . . 1200 lbs. working pressure . . . baskets, stainless steel . . . size, 24" . . . weight, 10,000 lbs.



Style 530—flanged ends
Cast Iron: 1¼" to 10" inclusive
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Style M530—Screwed Ends With Mesh Basket ¼" to 4" sizes

● McAlear strainers come in sizes ½" to 24" . . . . flanged or screwed bodies . . . clamp or bolted covers . . . . bodies of steel or special alloys and baskets of stainless steel, brass, or monel . . . to serve any installation.

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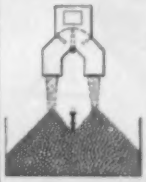
TYPICAL APPLICATIONS

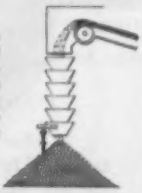
To indicate high or low level of material in a bin or silo. Lights or alarms can signal when high level or low level is reached.

When installed in chute between conveyors or between conveyor and processing unit, the feeding conveyor will be stopped if the chute should choke or plug up.



Installed in a bin fed by two or more inlets a RoBINtronic placed at the common valley will indicate the danger point should there be excessive filling from any one of the feed points.

A RoBINtronic can be installed so that a telescopic chute can progressively raise itself as the height of the pile increases.



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The RoBINtronic Level Indicator consists of two units . . . the *Electronic unit* and the *Probe unit*. A high frequency field is established by the *Probe* tip acting as an antenna. When this field is formed in free air a bridge circuit is caused to remain in balance.

When solid material approaches the *Probe* and enters the high frequency field the balanced circuit is disturbed and at a *predetermined degree* will relay a signal back to the *Electronic unit*. This can, through a power relay contact, stop or start motors or other equipment to control the flow of materials.

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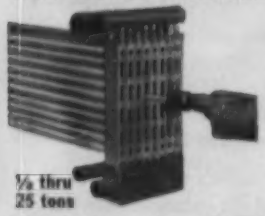

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NOW, being used for boiler, manhole, handhole and face plate studs, turbine header studs, flange bolts on high temperature valves, steam lines, pumps, etc.

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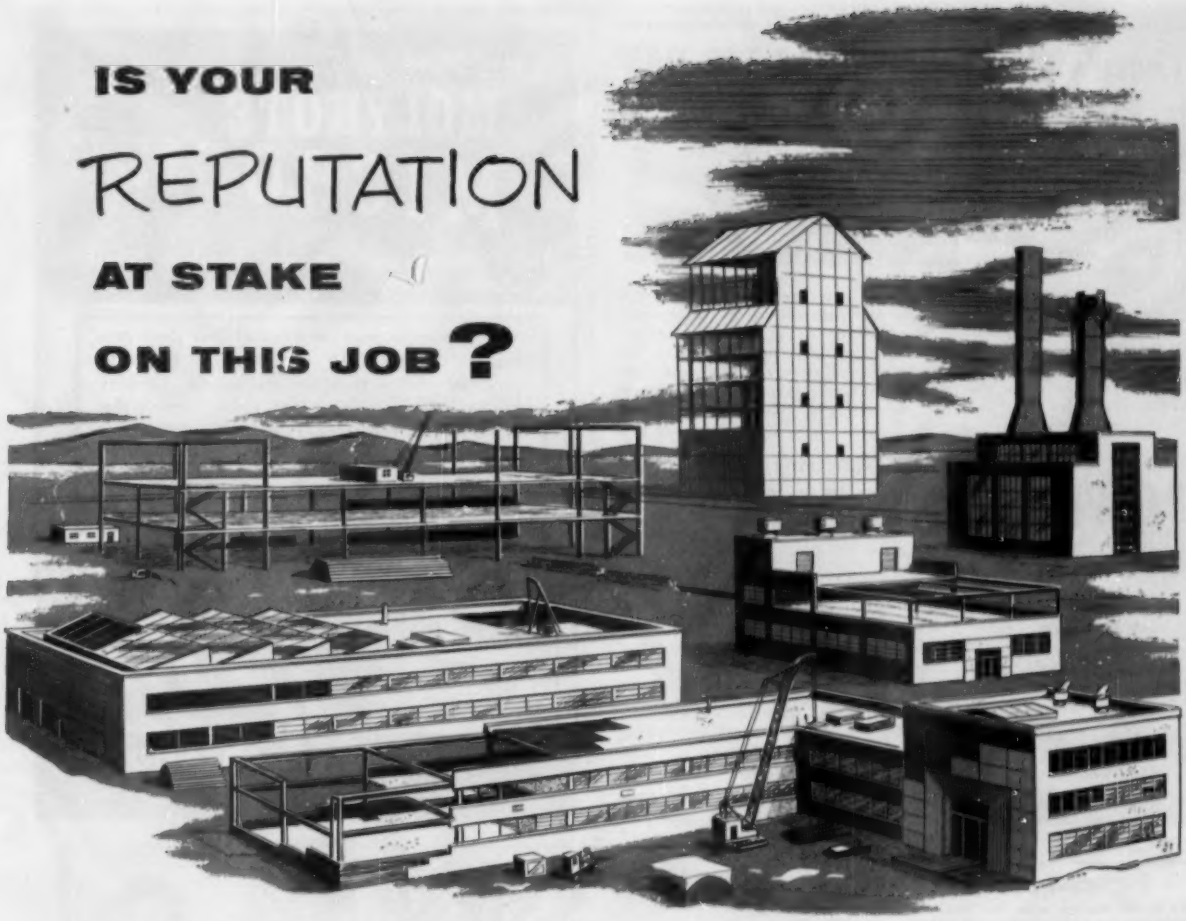

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"Information on MOLYKOTE appears in Sweet's Product Design File, 1955, Section C."

For more detailed information, write today for our Bulletin 104.

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Better buy the New Armstrong Y-type Pipe Strainers —they're trouble-free

Corrosion-resistant stainless steel screens are standard. No maintenance problems here.

Locked in copper-asbestos gasket cannot blow out. Provides a positive leak-proof seal with only a light torque on the bushing.

Straight bushing threads prevent sticking or "freezing" in. Bushing and screen are always easy to remove.

6 sizes (½" to 2") in semi-steel for pressures to 250 psig and 3 sizes (½", ¾", 1") in cast steel or moly steel for pressures to 900 lbs. Available with 20 x 100 mesh wire screens or perforated screens (.045" dia. holes, 225 per sq. in.).

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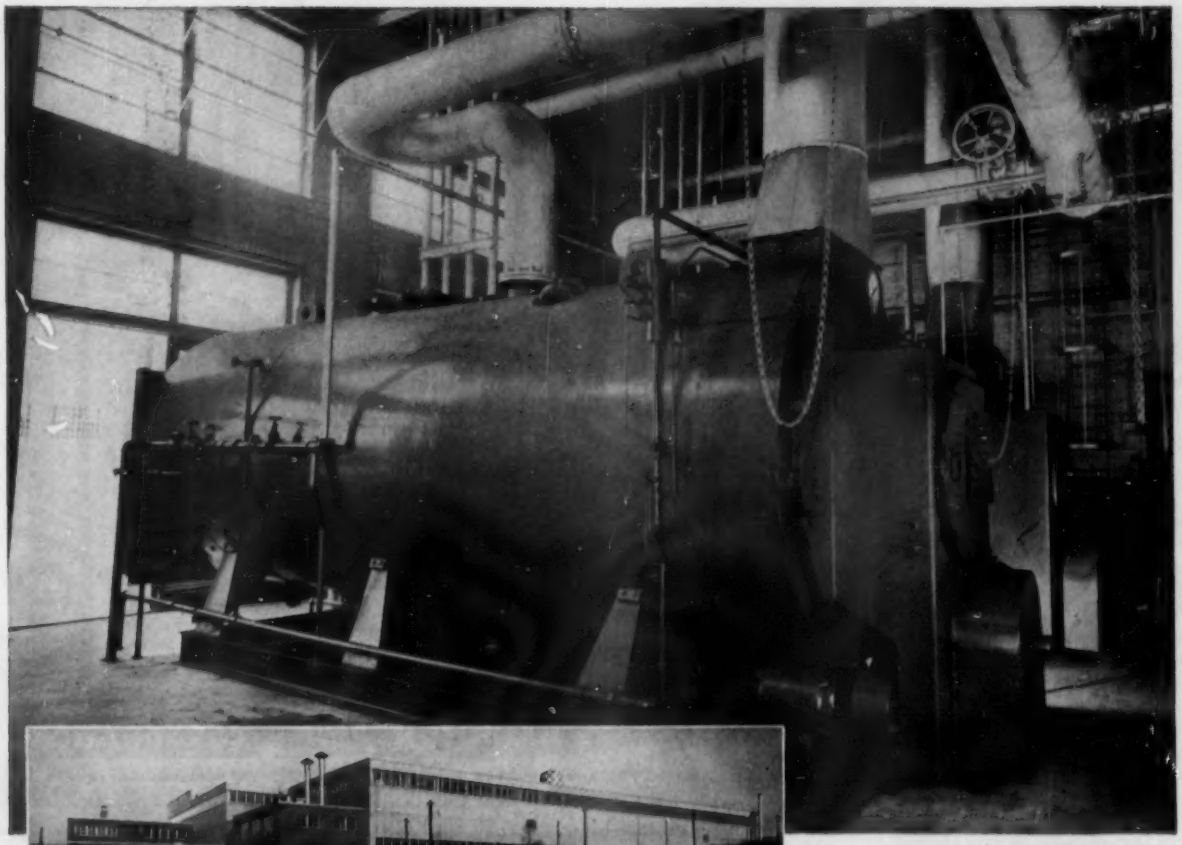
Get facts and details, write for Bulletin No. 300.

Satisfaction Guaranteed!

ARMSTRONG Y-TYPE PIPE STRAINERS



View of two 500 hp Continental Boilers at Tube Reducing Corporation's newest plant — Rockrite Products Div., Wallington, N. J.

100,000 sq. ft. new plant addition at Tube Reducing Corp., Wallington, N. J. This new plant is sponsored by the U. S. Navy, Bureau of Aeronautics. Consulting Engineers: Lockwood & Greene, New York, N. Y.; Heating Contractor: Frank A. McBride, Paterson, N. J.; Builder: James Stewart Corp., New York, N. Y.

CONTINENTAL BOILERS

. . . known by the company they keep

These twin 500 hp Continental Boilers are installed in a new plant that is the last word in modern efficiency — Tube Reducing Corp., Rockrite Products Division, Wallington, N. J. Besides furnishing steam for processing, they are supplying more than enough steam to heat the 100,000 sq. ft. new plant addition. They serve efficiently the men and machines that produce Rockrite Tubing — a precision product for military and industrial applications.

The Continental is the packaged boiler that features the "spinning gas technique". A forced draft fan delivers air to concentric rows of guide-vanes which direct the air in a spinning stream into the burner. These vanes form, in effect, a multiple-lead air-screw that provides uniform delivery of air and thorough mixing of air with fuel. The result: a high rate of heat transfer to the surrounding water-cooled furnace.

For details on Continental Boiler's "Spinning Gas Technique", send for Bulletin BE-4A.

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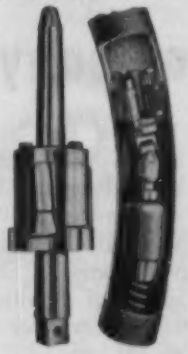
For re-rolling old tubes or installing new ones. Precision-made to insure firm seating. Self-feeding and parallel expansion for a particular trade.



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FINANCIAL AID TO HIGHER EDUCATION

Our Colleges and Universities Are Living on Borrowed Time

. . . time borrowed from underpaid faculty members

The chart on this page tells a story of profound importance to every American. It is the story of the financial beating our college and university faculty members have been taking in the past 14 war and postwar years.

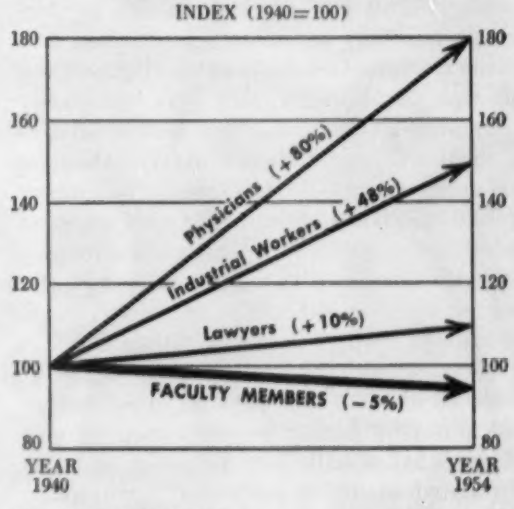
On the whole, this span of 14 years has been one of great and growing prosperity. But, as the chart shows, our college and university faculty members have, as a group, had less than no share in it.

During this period, from 1940 through 1954, the real income of the average industrial worker (that is, what his wages would purchase in goods and services) has increased by almost one-half. Among professional groups, physicians have enjoyed an increase of about 80 per cent in their real income. Lawyers, far less favored financially, have had an increase of about 10 per cent. But faculty members have not only had no increase at all; over these years of prosperity their average real income has fallen by 5 per cent. These figures do not take account of the increase in taxes since 1940.

Senior Teachers Hardest Hit

These figures are, of course, averages. For some groups of faculty members it has been better; for others worse. It has been particularly hard on senior faculty members. Between 1941 and 1953 their salaries lost about 8 per cent of their purchasing power. Being deeply committed to their careers they could not respond to alternative employment opportunities as readily as could their junior colleagues. For junior faculty members there was some increase in real income between 1941 and 1953 but only about half as much as the average for the nation.

What's Happened to College Faculty Salaries*



* Real Income before Taxes

Source: Council for Financial Aid to Education; U. S. Dep't of Commerce; U. S. Dep't of Labor.

Public Colleges Fare Better

There are also marked differences in the average financial reward received by faculty members in different types of colleges and universities. A recent study by the Council for Financial Aid to Education indicates that, in the last academic year, 1953-1954, teachers in privately endowed, independent colleges and universities were paid an average salary about $1000 less than that paid to faculty members in tax-supported institutions. The same study indicates that salaries far below the average are especially common for faculty members in the small private liberal arts colleges. This study found that during the last academic year the average salary of all college and university faculty members was about $4700.

The special difficulties under which the independent colleges and universities, and particularly the independent liberal arts colleges, are laboring to get back on their feet financially have been discussed in previous editorials in this series. These difficulties underline the need of special help for these institutions to which business firms are now contributing in increasing volume. However, the problem of providing better salaries is not peculiar to any particular type of institution.

Faculty Members Not Greedy

It is not easy to prescribe a precise standard of fair pay for college and university faculty members. This is partly because they put less weight relatively on money rewards than they put on rewards of scholarly accomplishment and prestige. Consequently, they have consistently been willing to work for very modest salaries in relation to the intellectual ability, education and application required. Obviously, however, it is the dictate both of fairness and good judgment to see that faculty members are given a roughly proportionate share in the general prosperity. Indeed, their crucial role in our society could be made to justify a larger share than this.

There is no way to know with any degree of precision what the underpayment of our college and university faculty members over the past 14 years has actually cost the nation in terms of reduced quality of intellectual performance of those institutions. One reason is that the damage has been minimized by the devoted services of many faculty members who have loyally stuck to their jobs in spite of the great financial discouragement.

It is obvious, however, that, if no grave deterioration in the intellectual performance of our colleges and universities has occurred so far, it is because we have been living on borrowed time. It is time borrowed from faculty members who have, in effect, been subsidizing these institutions by their financial sacrifice. This arrangement is not only a menace to the cultural and intellectual life of the nation, it is also a menace to our national security in a time when successful national survival may well depend in peculiar degree on the full development and utilization of our intellectual resources. We depend on our college and university faculties pre-eminently to provide this development. Adequate financial reward for such service is an elementary form of national insurance.

Many of our colleges and universities are working hard to improve the financial lot of their faculty members. Business firms are also playing an increasing role of providing the necessary financial assistance. The methods being used by business for this purpose will be the subject of another editorial in this series. However, **vastly more must be done, and quickly, to stop the financial beating being taken by our college and university faculty members if the nation's welfare and safety are to be properly protected.**

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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Available with moisture barrier attached, for use over 85% magnesia insulation.

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Address Childers Manufacturing Co., Dept. PO-10, 3620 W. 11th St., Houston 8, Texas.

Engineering representatives in all principal cities to work with you on your problems.

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WANTED: ELECTRICAL or power engineer. In midwest pulp and paper mill. College degree necessary. Age 25-35 years. Operating experience not necessary but desirable. Applicant must be capable of working on engineering projects. In first letter give complete resume of experience, age, education and required salary. P-5459, Power.

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Strong leadership qualities, ability to work with others and thorough work methods are necessary assets for this position.

Salary based on ability and experience.

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(Continued from preceding page)

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POWER AUTHORITY OF THE STATE OF NEW YORK
ST. LAWRENCE POWER PROJECT
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SPECIFICATIONS NO. PA-4-14002
ST. LAWRENCE CONTRACT NO. P7

NOTICE TO CONTRACTORS: The POWER AUTHORITY OF THE STATE OF NEW YORK will receive sealed proposals for the design, manufacture and furnishing of 86,000 kva, single phase power transformers and delivery thereof f.o.b. Massena, New York, until 10:30 a.m. Eastern Standard Time, March 22, 1955, at the Authority's office, 270 Broadway, Room 1207A New York 7, New York, at which time and place proposals will be publicly opened and read aloud.

Bids will be entertained for 13, 7, 6, or 1 power transformers and associated equipment and services in accordance with the bidding schedules. Erection at the site of installation will be done by others but services of erection engineers shall be provided by manufacturers if and when required.

Bids will not be restricted to American manufacturers.

Plans, specifications and proposal forms for the work will be on file in the Authority's office and in the offices of the Engineer, Uhl, Hall & Rich, 230 Congress Street, Boston 10, Massachusetts, and the Hydro-Electric Power Commission of Ontario, 620 University Avenue, Toronto 2, Ontario, and may be inspected by prospective bidders during office hours.

Plans, specifications, and proposal forms may be obtained from the Power Authority of the State of New York, 270 Broadway, Room 1207A, New York 7, New York, upon application and prepayment of a fee of Ten ($10.00) dollars per initial set of contract documents and Five ($5.00) dollars per set for additional sets, no part of which will be refunded. Two sets must be returned with each bid.

Bids must be made in duplicate upon the proposal forms included in and bound with the Contract Documents. Guarantee will be required with each bid in an amount not less than 10 percent of the maximum price bid for any schedule.

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TOTAL CAPACITY 70,000 KW

A COMPLETE POWER PLANT INSTALLATION, *Excellent Condition*

1—33,333 KVA—30,000 KW, 90% P.F., 3 phase 60 cycle, 12,000 volts, 1800 RPM, General Electric Company condensing turbine generator unit, 235 PSIG, 525°FTT, complete with direct connected shaft exciter, switchgear, 33,000 sq. ft. Westinghouse surface condenser and condensing auxiliaries.

2—25,000 KVA—20,000 KW, 80% P.F., 3 phase 60 cycle, 6600/13,200 volts, 1800 RPM, General Electric Company condensing turbine generator units, 235 PSIG, 525°FTT, each complete with direct connected shaft exciter, switchgear, 30,000 sq. ft. Westinghouse surface condenser and condensing auxiliaries.

DUAL DRIVEN CIRCULATING PUMPS

2—40,000 GPM Westinghouse circulating pumps, Size WX2, 290 RPM each connected to a 300 HP Westinghouse non-condensing steam turbine, 2950 RPM, 200-225# pressure, 125°F superheat, Westinghouse reduction gear ratio 2900—290 RPM, each direct connected to a 300 HP Westinghouse, Type CS motor, 3 phase 60 cycle, 440 volts, 290 RPM.

1—36,000 GPM Wheeler Condenser & Engineering Company circulating pump, Size 36" D.A.A. connected to a 234 HP General Electric Company single stage non-condensing steam turbine, 200-225# pressure, 3680 RPM, General Electric reduction gear ratio 3600/665/230 RPM, connected to a 250 HP General Electric Company, Type M.T. slip ring motor, 3 phase 60 cycle, 440 volts, 230 RPM.

CONDENSATE PUMPS

1—Westinghouse condensate pump, Size 28, external head 41 ft., 2000 RPM direct connected to a 36 HP Westinghouse non-condensing steam turbine, 200-225# pressure, 125°F superheat.

2—Wheeler Condenser & Engineering Company condensate pumps, Size 5"; 600 GPM, 1750 RPM, total external head 100 ft., each direct connected to a 27 HP General Electric non-condensing steam turbine, 1750 RPM, 200-225# pressure, 125°F.

1—Westinghouse condensate pump, Size 8", 1750 RPM, direct connected to a 38 HP Westinghouse non-condensing turbine, 200-225# pressure, 1750 RPM.

STEAM JET AIR PUMPS

2—Westinghouse steam jet air pumps, Size G-4, 150# pressure, 1320# steam per hour.

1—Wheeler Condenser & Engineering Company steam jet air pump, Size F, 135# pressure, 1800# steam per hour.

1—Croll Reynolds Company turbine closed heater 865 sq. ft.

1—Elliott Company turbine closed heater 850 sq. ft.

WATER TUBE BOILERS

5—2000 HP Babcock & Wilcox sectional header cross-drum water tube boilers, ASME Code, 250# pressure, equipped with superheaters, Allis Chalmers stokers, motor-driven forced draft fans, motor generator sets for stoker drive.

5—Allis Chalmers Stokers each driven by 10 HP Allis Chalmers shunt wound direct current motors, Type E-100, 250 volt, 35 amperes, 1080-1410 RPM.

MOTOR DRIVEN FORCED DRAFT FANS

4—Buffalo Forge Company, #10 forced draft fans each connected to a 165 HP, Type B.T.S.-15A, General Electric Company alternating current variable speed slip ring motor, 3 phase 60 cycle, 440 volts, 930/627 RPM.

MOTOR GENERATOR SETS

3—30 KW Allis Chalmers direct current generators, shunt wound, 250 volts direct current, 120 amps., 1750 RPM, Type EI-120, each direct connected to a:

50 HP Allis Chalmers induction motor, 3 phase 60 cycle, 440 volt, 58 amperes, 1750 RPM, Type AR-220 AS, with direct connected exciter, 8 amps., 250 volts, 1750 RPM.

TURBINE UNITS CAN BE INSPECTED IN OPERATION

We own and offer turbine generator units from 200 KW to 30,000 KW. Diesel engine generator units 200 to 2000 KW, motor generator sets and rotary converters.

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3—3750 KVA, G.E. type OA, 4687 KVA forced air, 26400 volts pri., 2 taps above and below, 4360/2520 volts sec. with fans, steel structure, outdoor, 1-million KVA interrupting breaker, etc. Purchased 1951, never used.

TRANSFORMERS 60 CYCLE

Qu	KVA	Make	Type	PH.	Voltages
2	3750	G.E. New	OISC	3	26400x4160
1	1000	G.E.	Auto	3	4150x2400
1	1000	Amer.	OISC	3	4150x480
1	750	G.E.	HT	3	4150x120/240
2	750	G.E.	H	1	4600x120/240
1	500	Kuhl	OISC	1	4600x2300
2	400	Pitts.	OISC	1	4150x240/480
1	333	G.E.	H	1	13200x220/440
1	300	G.E.	H	1	13200x440
1	200	G.E.	HT	3	2400x240
1	200	G.E.	H	3	4150x2400Y
2	150	Pitts.	ODSC	1	230x115/230
1	50	Whse.	S	1	2400x120/240
1	50	Amer.	OISC	1	13200x220/440
3	50	Whse.	S	1	2400x240/480
2	50	G.E.	H	1	2300x115/230
1	50	G.E.	H	1	2300x110/220
1	50	Amer.	AT	1	230x220/440
1	37½	Amer.	H30	1	6900x220/440
3	37½	G.E.	H	1	2400x120/240
1	37½	G.E.	H	1	13800x220/440
3	25	Niagara	OISC	1	4160Yx480
1	25	Moloney	HE	1	2300x115/230
1	25	Whse.	VR	1	2400x240/480
1	25	G.E.	H	1	11500x23460
1	10	Packard	A	1	650x110
1	10	G.E.	H	1	220/440x110/220

MOTOR GENERATOR SETS

Qu	KW	Make	Speed	DC	AC
1	1000	G.E.	514	600	2300/4150 3yn
1	1000	Whse.	720	600	2300/4150 3yn
1	1000	Whse.	720	275	2300/4150 3yn
1	300	G.E.	1200	250	2300/4150 3yn
1	300	G.E.	1200	250	2300/4150 3yn
1	200	Whse.	900	250	2300/4150 3yn
1	100	G.E.	900	250	2300 3yn
2	97	G.E.	1200	60	4150 3yn
1	75	G.E.	1800	250	220/440 3C
1	60	Whse.	1200	60	2300 Y
2	60	EM	1200	125	220
1	30	Whse.	900	230	450
2	30	G.E.	1750	240	220/440
1	20	G.E.	1800	230	220 Y 3yn
1	20	EM	1800	125	220 Y
1	7½	Allis	1800	125	220/440
2	5	G.E.	1800	125	220/440
2	1½	G.E.	2666	800 cy 1 ph	110/440
2	3	G.E.	1800	250	220/440

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PHONE NEW YORK (CONGRESS)

PHONE UNION

Member of The National Industrial Service Association, Inc.

SYNCHRONOUS MOTORS

QU	HP	Make	Speed	Type	Volts
1	500	Whse.	450	HR	2300
1	400	Whse.	450	HR	550
1	250	Whse.	450	HR	440
1	100	EM	720	TEFC	2300
1	100	G.E.	600	ATI	600
1	200	Whse.	600	ATI	240
1	175	G.E.	720	AT5	2300
8	150	G.E.	1200	TS	4150
1	150	G.E.	1800	TS	220
1	150	Whse.	900	181G	220
2	150	Allis	380		2300
1	125	EM	900		4800
1	100	G.E.	900	TS	2200

SLIP RING MOTORS

QU	HP	Make	Speed	Type	Volts
1	500	G.E.	1200	M	2400/4150
1	400	Whse.	450	CW	550
1	250	Whse.	60	CW	440
2	200	Whse.	600	CW	440
1	200	G.E.	600	MT	440
1	150	A.C.	1800	AY RW	2300
1	100	G.E.	1800	IM	220
1	100	G.E.	600	IM	440
1	75	G.E.	1000	IM	440
2	60	G.E.	1800	MT	220
1	60	G.E.	900	MT 546	440
2	50	G.E.	1800	MT527	220/440
1	50	G.E.	1200	MT536	220/440
2	50	Whse.	900	CW	220/440
2	50	G.E.	600	MT	220/440

DC, 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
1	200	G.E.	1200	MFC
2	150	C.W.	850	WP
1	125	G.E.	1700	BC
2	75	C.W.	900	WP
1	30	C.W.	700	CM
1	25	G.E.	860	BC
1	25	Whse.	835	SK

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37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
600	2300	Whse.	450
500	2300/4000	G. E.	900
438	440	Whse.	514
400	440	Whse.	720
300	2300/460	G. E.	720
300	440	G. E. (hoist)	600
300	2300	G. E.	900
300	440	Whse.	3000
250	440/220	Whse.	600
250	550/440	G. E.	1200
200	440/220	Whse.	514
150 (2)	440/220	G. E.	720
150	2300/440	G. E.	600
125	440/220	G. E. (hoist)	600
125	440/220	G. E.	900
125	550/440	G. E.	1200
125	2300	G. E.	600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

R.P.	Volts	Make	Type	R.P.M.
400	2200/440	G. E.	ATI	720
275	440/220	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/460	G. E.	TS	720
300	2300/440	G. E.	TS	1200
250	2300/440	G. E.	TS	720
250	440/220	Whse.	HR	277
250	440/220	G. E.	ATI	600
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2300	G. E.	PT	3600
500	2300/4000	Elliot	SC	1800
500	2300	G. E.		450
400	2300/460	Whse.	CS	720
300	2300	L. Allis	WS	1800
238 (3)	2300/440	G. E.	KT	1200
200	440	G. E.	IK	720
200	440/220	G. E.	KT	1800
200	2300/440	G. E.	IK	900
200	2300	G. E.	KT	1800
150	440/220	Whse.	CS	1800
150	2300	Al. Chal.	AR	1800
150	220	Whse.	CS	1200
150	440/220	G. E.	IK	450
150	440/220	G. E.	KT	720
150	2300/440		KT	600

A. C. GENERATORS

1—220 kva, 600 rpm 2300/460/230 V., G.E.
1—300 kva, 900 rpm, 480/220 V., G.E.
1—225 kva, 900 rpm, 220/440 V., G.E.
1—300 kva, 720 rpm, 2300/440 V., G.E. (Ball)
1—187 kva, 1200 rpm, 2300/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. OO K., 3 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKR-158-28, 600 amp., 15,000 V., G.E.
1—FKR-143, 1200 amp., 4500 V., G.E., Sol. op. (new)

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	2975
150	230	Whse.	SK	1750
100	230	Whse.	SK	400/1200
90	230	G. E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
200	Whse.	2200	Syn.	250
175	G. E.	220/440	Syn.	230
125	G. E.	440/220	Syn.	250/125
100	Al. Ch.	220/440	sq. ca.	240/120
100	Whse.	440/220	sq. ca.	125
75	G. E.	2200/440	Syn.	125
45	G. E.	2300/440	sq. ca.	250

TRANSFORMERS 60 Cy.

1—500 kva, Standard, 13,800-2300 V., 3 ph.
3—500 kva, Whse., 66000—2300 V.
3—333 kva, G. E., 12000—2300 V.
3—300 kva, G. E., 2300—575 V.
3—300 kva, G. E., 11000—2300 V.
3—200 kva, G. E., 4150—480/240 V.
3—150 kva, Al. Chal., 2400—240/480 V.
3—100 kva, Whse., 2400—120/240 V.
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32-E-12 F&M 12x15, w/9x9 York, 360 RPM $1850
32E F&M 2 cyl. 14x17, w/generator 1950
32E F&M 2 cyl. 14x17, w/clutch 1750
25E F&M 6 cyl. 8¾x10, 188 HP 1900
120 HP Atlas 6 cyl/w/clutch, rad. skids 1350
400 HP nat. gas Gen. Motors, 6 cyl. 8x10 3250

LIGHT PLANTS AC

2—20 KW Ideal, Engines Waukesha MER, Ea. $1150
3—9.5 KVA, New, gasoline driven ..... Ea. 785
1—30 KW Lorimer, diesel driven 1900
1—15 KW Hill diesel, single phase 1125
1—35 KW, D-4600 Caterpillar Diesel 1500
1—100 KVA, Mod. D-1742 Buda diesel 3000
1—300 KW, Mod. 8-268A General Motors .. 12000

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5—1250 HP Allis Chalmers, 1180 RPM, type ANW, 3/60/2300 volts, 270 amps, (typical serial #154341), excellent used condition.

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A PARTIAL LIST OF OUR INVENTORY

KW	MAKE	MODEL	HP	RPM
1180	Worthington	SEH-8	1685	360
1136	Fairbanks Morse	38D	1600	720
1100	General Motors	16-278A	1600	720
1000	General Motors	16-567B	1440	720
750	General Motors	12-567	1080	720
700	Worthington	EE-8	1000	327
675	Fairbanks Morse	38D	960	720
*500	Alco	6-12½x13T	750	600
500	General Motors	8-567	720	720
*350	Baldwin	VO-6	510	450
320	Superior	60-S-6	460	450
*320	Enterprise	DSG-6	460	450
300	Fairbanks Morse	32E14	450	300
300	General Motors	8-268A	450	1200
200	General Motors	8-268A	350	900
*160	Buckeye	80	240	600
148	Fairbanks Morse	32E14	225	300
100	General Motors	3-268A	150	1200
60	General Motors	6-71	90	1200

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STANDARD AND SPECIAL VOLTAGES AS REQUIRED
*—*indicates NEW unit*

ONE YEAR GUARANTEE!

MOTORS!

Amt.	HP.	Speed	Make	Type	Frame
3	250*	600	G.E.	KT568 (2200V)	
1	200	900	A-C	AR830D	
1	150*	1800	Whse.	CS (2200V)	817S
1	150*	1800	A-C	26F-220-42-10	
2	150*	1800	A-C	AWW new	22BS6
1	150*	900	G.E.	I-K (2200V)	
1	125	1200	Wag.	26WBP	
1	125	1800	Whse.	CS	4 Mil.
1	100	1800	Howell	K (TEFC)	
1	100	1800	Whse.	CS	663C
1	100	1200	Whse.	CS	782C
2	100*	1200	A-C	AR (2300V)	823E
1	100*	900	A-C	2300 V 2K20064.1	
5	75	1800	Howell	220-440 V	504
1	50	1720/575	L-A	Adjusto-Spede	445

*2300 volts

SLIPRING

1	100	900	G.E.	MT356	
1	100	450	G.E.	I-M (2200V)	16
1	75	720	A-C	(1-2200 V)	
2	75	900	G.E.	I-M	

PARTIAL LISTINGS—10,000 OTHER MOTORS IN STOCK—NEW & REBUILT—A.C. & D.C. NEW MOTORS AT LONG DISCOUNTS

BENSON-WILIMZIG, INC.
1704 North 8th Street
Phone GArfield 1-4290
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1—80 HP 200# & 300 HP 125# E. City Boilers
2—250 HP 200# Erie City W.T. Boilers
2—300 HP 200# Sectional Header WT Boilers
2—800 KW Gens. dir. con. Corliss Engines
1—125 HP 150# & 75 HP 125# Locomotive Type
1—150 HP Westinghouse Squirrel Cage Motor
1—Model DRXB Hercules Diesel—A&1 Cond.
1—#848 B/G Asphalt Mixing-Gradation Unit
H. & P., 6719 Etzel, St. Louis 14, Mo.

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Custom-built transformers and coils manufactured to your specifications.

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BREW WOLTMAN *Offers—*

3500 KW 80% PF West. Cond. Turbo Gen., 3-60-2400/4160 V., 3600 RPM 400 PSIG, 750° TT, dir. con. exciter, surf. cond. New 1948.

3000 KW 80% PF G.E. Cond. Turbo Gen. 3-60-2400/4160 V., 3600 RPM, 385 PSIG, 750° TT, dir. con. exciter, surf. cond.

4000 KW 80% PF G.E. Non-Cond., auto extr. Turbo Gen. 3-60-13800 V., 3600 RPM 600 PSIG 750° TT, 135# extr., 50# max. BP. NEW.

Full line power equipment—send us your inquiries.

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WIRE WRITE OR PHONE CAnal 6-2900

D. C. MOTORS — 230 Volt

HP	Make	Type	Speed
250	Westg	SK-250	450/600
200	Westg	SK-201	600
200	Cr. Wh	CM	500
175	G.E.	ELC	750
100	G.E.	MPC	400/600
100	G.E.	RC-34	2500
100	G.E.	RC-19	575
100/150	G.E.	MCF	300/1000
75	G.E.	RCP-24	1750
75/25	Westg	SK-151	400/1600
50/120	G.E.	MCF	250/1000
50	Cr. Wh	CMC	700/1100
50	G.E.	DLC	650
25	Westg	SK-150	350/1000
30	Cr. Wh	CCM-504	450
30/40	G.E.	CD-115	500/1500
25	G.E.	RC-32	800
25	Westg	SK-132	575
20	star	SB-10	1750
20	Westg	SK-110	750
15	Westg	SK-102	400/1000
10/15	Reliance	185T	400/1600

SLIP RING MOTORS
3 phase, 60 cycle, 220 or 440 volts ("2300 volts or higher)

HP	Make	Type	Speed
2000	*G.E.	MT	600
1500	*G.E.	MT-30	240
1250	*Westg.	CW	600
1200	*G.E.	MT-24	300
1000	*Westg.	CW	250
700	*Al-Ch	ANY	720
600	G.E.	MT547	1800
600	*Westg.	CW	450
500	G.E.	I-17A	900
500	Westg.	CW	250
400	Al-Ch	3 brg.	450
400	*G.E.	MT-412	450
300	*G.E.	IE-15A	1800
300	*G.E.	MT-568	720
250	Westg.	HP-15H	600
250	*G.E.	I-17B	450
200	G.E.	IK-15B	900
200	G.E.	IM-17	600
150	Cr. Wh.	50-R	1800
150	G.E.	MT-549	1800
150	*Al.-Ch.	ANY-30F1	1200
150	Westg.	CW-868A	720
150	Westg.	CW	450
125	G.E.	IM-15A	600
100	G.E.	IM-13A	1800
100	G.E.	MT-556	900
100	G.E.	MT-558	720
100	G.E.	IM	600
100	G.E.	IM-15A	450
75	Nor. West.	MW-50	1800
75	G.E.	MT-547	1200
75	G.E.	IM	1200

MOTOR GENERATOR SETS

KW	Make	A.C.	D.C.
1000	G.E.	13200	600
500	Westg.	4600	250
400	G.E.	2300	270
400	Al.-Ch.	2300	120/240
250	Westg.	2300	125/250
200	G.E.	2300	250/275
200	Westg.	4160/2300	275
200	Ridgeway	2300	250
170	G.E.	440	125
150	G.E.	2300	125/250
150	Al.-Ch.	2300	275
150	Westg.	2300	1250/250
150	G.E.	440	275
100	G.E.	2300	250
100	Westg.	440	125
100	Elec. Mch.	440	125
100	G.E.	440	125
90	G.E.	440	60
75	G.E.	440	125
50	Reliance	440	250
50	Ideal	2300	250
50	Westg.	240	125
50	G.E.	440	125
25	Westg.	2300	150
25	Westg.	220	300
25	L-Allis	440	250
20	Gogue-G.E.	550	250
20	Gogue-G.E.	220-440	250
20	Gogue-G.E.	440	125
15	Westg.	220-440	250
15	G.E.	440	240
10	G.E.	220	250

SLIP RING MOTORS
Crane and Hoist Service
3 phase, 60 cycle, 220 or 440 volt

HP	Make	Type	Speed
80	G.E.	MTC-5552	600
75	Westg.	CI-756A	600
50	Westg.	MW-334	600
50	G.E.	HIC TNEV	600
35	G.E.	MTC-5536	600
20	Westg.	CI	1200
11	Westg.	CI-E404	900
10	P & H	BW-6	1800
5	G.E.	MTC-5730	1800
5	P & H	BW-6	1200
5	N. Western	WBC	1200
3	G.E.	MTC-5944	900

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GAS • DIESEL • STEAM • ELECTRIC
NEW AND QUALITY REBUILTS
STATIONARY

12.7 CFM 1000 psi 2 stage Ingersoll 5 HP Elec
46.6 CFM 3500 psi 3 stage Ingersoll 25 HP Elec
122 CFM 100 psi American 20 HP Elec
125 CFM 100 psi 6½x6½ Davey VBP-6 Available
142 CFM 125 psi 8/6/8x5 Ingersoll Type 40—25 Elec
211 CFM 100 psi 9½x9 American 40 HP Elec
234 CFM 100 psi 10x10 Ingersoll ER-1 40 HP Elec
268 CFM 500 psi 10/4½x18 Ingersoll 75 HP Synch
276 CFM 125 psi 2 stage Chicago PB-50 HP Elec
285 CFM 125 psi 2 stage Gardner "WB" 50 HP
291 CFM 40 psi 3 cylinder Ingersoll Type 40
294 CFM 100 psi 10x11 Ingersoll ES-1 50 HP Elec
343 CFM 500 psi 11/5x13 Worth Elec or steam
355 CFM 100 psi 12½x10 Americus WTR 60 HP Elec
364 CFM 20 psi 12x7 Gardner "RX" 2 available
426 CFM 100 psi 12x11 Ingersoll ES-1 NL—Oil-less
482 CFM 100 psi 12x11 Ingersoll ES-175 HP Elec
460 CFM 125 psi 15/9x10 Ingersoll XRB—Duplex
510 CFM 125 psi 15/8x12 Ingersoll XRB—Duplex
670 CFM 125 psi 15/9½x12 Ingersoll XRB—Duplex
861 CFM 30 psi 17x11 Ingersoll ES-1
931 CFM 35 psi 17x15 CPT Elec or steam
1065 CFM 35 psi 20x12 Penn-3A 100 HP Elec
1292 CFM 35 psi 20x13 Chicago Y-8 125 HP Elec
1574 CFM 90 psi 15/15x14 Penn DB-1 200 HP Elec
1723 CFM 110 psi "XPV" 4 corner Ingersoll steam
PORTABLE—15 CFM to 600 CFM
VACUUM PUMPS—3 CFM to 5681 CFM
SPECIAL—Compressors for special air applications and conditions
DELIVERIES—Always prompt.

American
AIR COMPRESSOR CORP
DELL AVE. & 47th ST.
NORTH BERGEN, N.J.
Telephone UNion 5-4848

BOILER FOR SALE
120 H.P.—CR 382 INTERNATIONAL
Water-tube with Petro oil-fired burner
Automatic Controls • Excellent Condition
Now in operation
MARCO PRODUCTS, INC.
Sycamore & Mill Rd., Clifton Heights, Pa.

MOTORS · MG SETS

Qty.	HP	Make	Voltage	Speed
12	3000	West.	525/600	600 RPM
28	1500	West.	525/600	600 RPM
32	1500	Al. Ch.	525/600	675 RPM
4	1200	Al. Ch.	525/600	650 RPM
2	900	Elliott	220	300/195 RPM
2	800	West.	525/600/600/900	RPM
1	650	Cr. Wh.	220	475/720 RPM
1	500	West.	220	250/500 RPM
1	450	West.	250	400/1200 RPM
1	400	G.E.	220	180/360 RPM
7	400	Elliott (new)	220	400/800 RPM
5	400	West. (new)	220	375/750 RPM
2	350	Cr. Wh.	220	400/800 RPM
1	200	Cr. Wh.	220	500/750 RPM
1	200	Cr. Wh.	220	375/750 RPM

All motors designed for mill reversing service.
Smaller sizes also in stock.
Motor Generator Sets in Stock
100—2000 K W Capacity
All of above is modern late type equipment remanufactured & tested by our engineers.
Write, Wire, Phone
All guaranteed for one year

A G SCHOONMAKER CO INC
50 CHURCH STREET, NEW YORK 7, N. Y.
Plants: SAUSALITO (S.F.) CAL., JERSEY CITY, N.J.

8,100 KVA
DIESEL POWER PLANT

For sale Complete, or as Individual Units. New 1943. Can be inspected operating.

3—Busch-Sulzer Diesel Engines, 3060 HP, 9 cyls., 2 cycle, 240 RPM, Type 9 DHB-27½, direct coupled to:

3—2700 KVA Electric Machinery Alternators, .8 PF, 2160 KW, 3/60/2300/4160 volts, with 30 KW, 125 volt, V-belted Exciters. Complete with all auxiliaries.

HEAT & POWER CO., INC.
70 Pine St., New York 5, N. Y.
HAnover 2-4890

DIESEL GENERATOR SETS

3—1400 HP Superior 8 cyl. 360 RPM 1000 KW Elec. Mchy. 3/60/2400 volt generators. Complete Plant. New 1949.

1—750 HP Superior 8 cylinder, 400 RPM, 500 KW Elec. Mchy. 3/60/2400 volt generator & auxiliaries.

1—400 HP Superior 4 cyl. 400 RPM Model VDSE, 250 KW, 3/60/2400 volt.

MISSISSIPPI VALLEY EQUIPMENT CO.
507 Locust St. St. Louis 1, Mo.

FOR SALE
18 NEW TURBINES
4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE
2457 WOODWARD AVE.
408 DONOVAN BLDG.
DETROIT 1, MICH.

DIESEL ENGINES AND GENERATORS

2—200 KW General Motors 8-268-A, 1200 RPM, (Ser. #6255 & 6256), with Westinghouse Generator (Ser. #118-12P-907 & 188-12P-907), 120-240 Volts DC. Units rebuilt by GM; complete with engine accessories.

2—450 HP General Motors 8-268-A Engines, (Ser. #6045 & 6054), 1200 RPM. Units rebuilt by GM; complete with engine accessories.

6—200 KW General Electric, type ATI, Generators, 1200 RPM, (for connection to above engines), 3/60/450 volts, 320 amps. with exciter 40 KW, GE, 120 volts DC. (typ. ser. #5063547), excellent used condition.

EASTERN SCRAP & SALVAGE CORPORATION
65 Muirhead Ave. Trenton, N.J.
OWen 5-6349

3750 KVA. — G. E., 400#, 750°, 2300-4160-V., TURBINE-GENERATOR

A VERY HIGH GRADE MACHINE: EXCELLENT CONDITION

WRITE US FOR COMPLETE INFORMATION TODAY.

Complete Unit: 2-Pass Surface Condenser.

Switchboard With Instruments Direct Connected Exciter.

ABOVE VIEW IS FROM A RECENTLY TAKEN PHOTOGRAPH.

We Carry Large Stocks of Turbine Sets, Diesel Engines, Boilers. In Turbines we cover Units from 500-KW. to 10,000-KW. Also Large Stocks of Diesels and Boilers.

Always Secure Our Prices Before Placing Your Orders.

WILL PAY YOU WELL TO DO SO. CORRESPONDENCE INVITED.

Telephone, Write or Wire.

CHARLES WEAVER, M. E.
19701 JAMES COUZENS HIGHWAY
DETROIT 35, MICHIGAN

Broadway 3-1901

O'Brien Offers—

MOTOR GENERATOR SETS

1—500 KW Crocker Wheeler CCD, 250 volt 720 RPM with 750 KVA Cr. Wh. Syn. Motor 3/60/2300 V. A.C. & D.C. Panels.
1—300 KW West. 3 wire 125/250 Volt 1200 RPM Generator (1938 year). Can furnish with suitable motor. Advise Requirement.
2—250 KW Burke 125 V. 435 KVA Syn. M.D. 3/60—any voltage
1—150 KW G.E. Type MPC—250 Volt 1200 RPM 3/60/2300/200 H.P. Syn. Motor Drive A.C. & D.C. Panels
1—100 KW G.E. RC 17, 125 v. 3/60/220/1200 rpm
1—100 KW Al. Ch. 250 V. 1200 RPM 150 HP. Syn. Mtr. 2/60 or 3/60 any voltage.
1—75 KW Burke 250 V. 900 RPM 113 H.P. Burke—Syn. M.D. 2 or 3 ph. any voltage.
2—70 KW Century, 1000 amp, 70 volt, 3/60/220/440
1—62½ KW 125 volt Hertner, 1200 rpm, 100 HP Sq. Cg. 3/60/220
2—50 KW G.E.—CD-105—250 V. 75 HP KT 537—3/60/440
1—6 KW G.E. 6 v. 100 amp, 3/60/220

DIESEL GENERATOR SETS

3—625 KVA Inger. Rand, 3/60/480/720 rpm
2—438 KVA GM-Winton 3/60/2300/360 rpm
375 KVA GM 8-268 Diesel 3/60/440
2—312 KVA Worth. CC-6, 3/60/220/480 rpm
300 KW GM 8-268 Diesel 125/250 V. D.C.
56 KVA Climax Gas 3/60/220
30 KVA LeRoi Gas 3/60/220
40 KVA Chrysler Diesel 3/60/220
25 KVA LeRoi Gas 1/60/120/240
1—10 KW Winchcrger 1/60/110-220 Gasoline

BOILERS

1—60,000# Erie Stoker New 160 psi
1—350 HP Cleaver Package 150 Lb.—1942
1—300 HP Keeler CP—160 Lb. Oil
2—250 HP Keeler Type CP-160 Lb.—1948
1—250 HP Ames Package Type (1948) 150 psi
1—100 HP Clayton Forced Recirculation Compact Self-Contained and Fully Equipped for Operation 160 lb. W.P.
5—18 HP Red-Line New Horizontal Oil Fired 150 lbs. W.P.

ELECTRIC MOTORS

QU.	HP	Make	Type	Volts	Speed
1	500	West.	CS	6600/2300	514
1	450	A.C.	ANY	2300	600
1	400	West.	CW	440	514
1	400	G.E.	Syn.	2300	450
1	350	G.E.	MT18	2300	400
2	200	West.	CW	2300	1800
1	200	G.E.	I.M.	440	514
1	150	G.E.	I.M.	440	600
1	150	G.E.	K T	440	600
1	125	West.	Syn. 3 brg.	550	600
1	100	Al. Ch.	SI. Rg.	2200	900
1	100	West.	CS	440	1200
1	100	West.	CW	440	900
1	100	G.E.	I.K.	2200	1200
1	50	G.E.	M T	440	1200

TURBO GENERATORS

1—11250 KVA G.E. 3/60/13200/3600 rpm—Condensing—Boilers—Complete Plant
2—4000 KVA Allis Chalmers 3/60/2300/3[illegible] rpm—Condensing

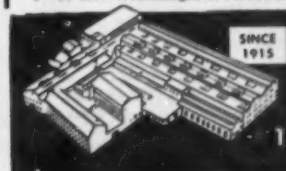
1—1250 KVA DeLaval Non-Cond. 3/60/2300. New 1940 240 psi 50 lb. B.P.
1—938 KVA GE-Terry Aut. Extr. 3/60/480 150 psi. 20 lb. B.P. Surf. Condenser 1934
1—780 KVA G.E.-Moore 3/60/2300/3600 RPM Non-Cond. 180 PSI 35 lb. B.P. New 1936.
1—75 KW G.E. Non-Cond. D.C. 125 volt.

AIR COMPRESSORS

1—1600 cfm IR PRE-2 Syn. Mtr. Dr. 3/60/2300—100 psi.
2—1300 cfm IR-PRE-2 3/60/2300—100 psi
1—978 CFM Sullivan 13x13x8, 45 psi.
1—670 CFM Chicago OCE Syn Mtr. Dr. 3/60/2300
1—368 CFM Chi. NSB, 12x10, 100 psi.
1—371 CFM Schramm 7½x5x4, 100 psi
1—173 CFM Chicago NSB 100 psi

OISC TRANSFORMERS

Qu.	KVA	Make	Pri. V.	Sec. V.	Phase
3	2000	G.E.	13200	230/460	1
3	1000	GE	13200	2300	1
1	1100	West.	4160	440	3
1	750	O'Brien (New)	13200	480	3
3	667	Al. Ch.	33000	2300	1
3	500	West. Dry	33000	2300	1
3	500	West.	22000	460	1
1	500	Gregory	4160	440	3
3	500	GE	13200	2300	1
3	400	GE	2400	480	1
3	333	West. Dry	2400	480	1
3	333	Pitts.	33000	2300	1
3	333	G.E.	13800	240/480	1
3	250	Al. Ch.	13,200	115/230	1
2	250	West. Dry	13800	230	1
3	150	West	2300	230/115	1
3	150	Dry	2300/4160	230/460	1
3	100	Dry	2300/4160	230/460	1
3	100	West.	4160	240/480	1
1	85	West.	4160	120/240	1



SINCE 1915

THE O'BRIEN MACHINERY CO.

T.M. REGISTERED U.S. PATENT OFFICE

PHILADELPHIA'S LEADING MACHINERY DEALERS & EXPORTERS

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"Everything from a Pulley to a Powerhou[illegible]"

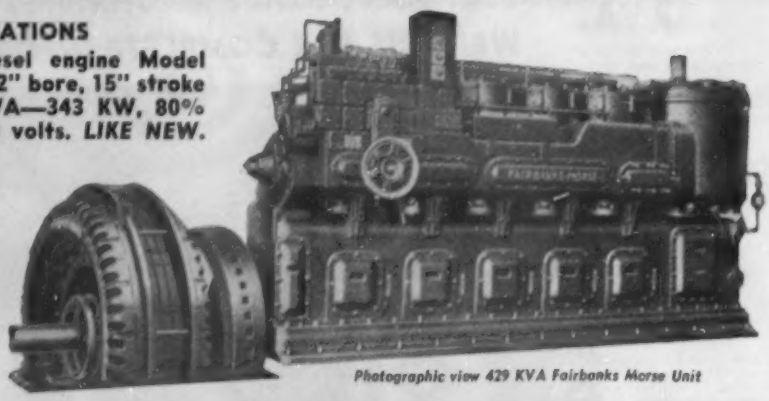
AFFILIATED WITH SOC EXPANSO INDUSTRIAL SUL AMERICANA LTDA RIO DE JANEIRO—BRASIL

SPECIAL BARGAIN OFFERINGS
FAIRBANKS MORSE DIESEL GENERATORS

COMPLETE INSTALLATIONS

500 HP Fairbanks Morse Diesel engine Model 33-F-12, 5 cylinders, 400 RPM. 12" bore, 15" stroke direct connected to a: 429 KVA—343 KW, 80% PF, F. M. generator 3/60/2400 volts. *LIKE NEW. INSTALLED 1948.*

690 HP Fairbanks Morse Diesel engine Model 33-E-14, 6 cylinders, 300 RPM, 14" bore, 17" stroke direct connected to a: 592 KVA—473 KW, 80% PF, F. M. generator, 3/60/2400 volts. *EXCELLENT CONDITION INSTALLED 1949.*



Photographic view 429 KVA Fairbanks Morse Unit

UMC UTILITIES MACHINERY CORP.
1965 EAST 6th STREET • CLEVELAND 14, OHIO • CH. 1-0210

3 G. M. 200 KW DIESEL GENERATOR SETS

Reconditioned by U.S. Navy

EQUAL TO NEW

Complete with motor driven starting air compressors, air tanks, dead front type generator switch panels and all other necessary accessories.

ENGINES

G.M. Model 8-268A—8½X7—1200 RPM—air starting—complete with engine operating panels, heat exchangers, cooling pumps, filters, strainers, governors, pyrometers, etc.

GENERATORS

Westinghouse 200 KW 250 KVA—440/3/60—1200 RPM—80% P.F.—continuous—drip-proof enclosure—direct connected exciter.

SIZE AND WEIGHT

Each unit, mounted on a pre-fab sub-base, is 13' 9 5/16" long, 8' 10½" wide, approx. 8' high. Weight of engine and generator only, 17,705 lbs. Each unit, with all accessories, about 27,000 lbs.

CONDITION

No expense has been spared to put these 3 units in "equal to new" condition. Don't miss this opportunity to buy! Inspection can be made at our warehouse, Curtis Bay, Baltimore.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD CURTIS 7-5050

COMPLETE POWER PLANT STEAM GENERATORS

1—800 K.W. Hor. Corliss engine (Fulton) with G.E.—A.C. Generator. 2300 volts

1—800 K.W. Cross Compound non-cond engine Allis Chalmers with A.C. generator G.E. 2300 volts

2—1500 K.W. Cross Compound cond. Corliss engines. Driving A.C. generators. G.E. 2300 volts

1—5500 sq. ft. Alberger condenser with assoc. circulating pump, vacuum pump and hot well pump.

1—5500 sq. ft Worthington Condenser with assoc. circulating pump, vacuum-pump and hot well pump.

Oil Circuit Breakers, Field Rheostats and Switch Board Panels with Electric Control Equipment for above listed A.C. Generators.

PAUL OBERMAN
MIDWEST IRON & METAL CO.
1910 Delmar Blvd. St. Louis 3, Mo.
GArfield 1910-1911
"Power Plant Located in Springfield, Ill. Specifications Mailed Upon Request."

COMPLETE POWER PLANT

4—1285 HP B. & W. Boilers, rated #225 psig steam, A.M.S.E. code, lower tubes retubed in 1952, C/W underfed stokers, boiler feed pumps, blowers, Cochrane Heater, pipes, valves, etc.

1—15,000 KVA G.E. Turbo-Gen. Set, type ATB-4, 3 ph., 60 cy., 9000 v., 1800 R.P.M., d/c to a Curtis Condensing Turbine, #200 psig steam, 20,000 sq. ft. Surface Condenser and all other equipment.

1—Skip Hoist Unit, 60 cu. ft. electric driven with 70 ft. Elev. Tower and Cone Shaped Steel Storage Bunker, Catenary Suspension for truck or car loading. Complete.

1—15 ton Link-Belt Std. gauge, 8 wheel, Steam Locomotive Crane, new 1931.

Location—Albany, New York. Price upon request.

PHILA. TRANSFORMER CO.
2829 Cedar St. Phila. 34, Pa.

FOR SALE
BOILER

500 HP late model Boiler, self-contained, automatic.

ADELPHIA EQUIPMENT CO.
341 North Third St., Philadelphia 6, Pa.

1250 KW TURBOGENERATOR CONDENSING EXTRACTION

1250 KW 80% pf 1563 KVA General Electric, 165/300 lbs. pressure, 700 deg. FTT, 5/10 lbs. automatic extraction, 3 phase 60 cycle 480 volts, equipped with 3000 sq. ft. surface condenser, auxiliaries and switchboard.

OHIO POWER MACHINERY COMPANY
13661 Euclid Ave., Cleveland 12, Ohio

L. J. LAND, Inc.
ESTABLISHED 1910
One of America's Largest Stocks of
MOTORS — GENERATORS and ELECTRIC EQUIPMENT
A.C. and D.C.
Any H.P. or Voltage
Standard and Specials
REBUILT IN OUR OWN SHOPS!
1 Year Guarantee
148 Grand St. New York 13, N. Y.
CAnal 6-6976

FOR SALE
FAIRBANKS-MORSE DIESEL ENGINES

Model 32 E 14—2 Cylinder 150 H.P. @ 300 R.P.M. Almost New—Price Cheap!! 2-Available.

Write For Full Specifications

GLOBE TRADING COMPANY
1815 Franklin St., Detroit 7, Mich.
Phone WO 18277

BABCOCK WILCOX

Boilers for sale at bargain prices. Two 800 HP and One 682 HP, 200 PSI Steel Sectional Headers, located Arkansas.

FS-5030, POWER
330 WEST 42 ST., NEW YORK 36, N. Y.

DIESEL GENERATOR SETS

100 KW General Motors Model 3-268A, A.C. & D.C. units. Rebuilt
60 KW G.M. Model 6-71. Rebuilt A.C. & D.C. Gen. sets.
Various types & sizes in Stock
ALJON ELECTRIC DIESEL CO.
904 Pacific St. Brooklyn 38, N. Y.
STerling 3-4515

RE-NU-BILT
GUARANTEED
ELECTRIC POWER EQUIPMENT

D. C. MOTORS

Qu.	HP	Make	Type	Volts	RPM
1	2200	G.E.	MCF	600	400/500
1	3000	Whse.	Mill	600	230/460
1	1400	G.E.	MCF	600	63/190
1	1200	G.E.	MCF	600	750/950
1	940	Whse.	QM	250	140/170
1	900	Whse.		250	450/560
1	825	Whse.		250	95/190
1	400	Al. Ch.		250	400/800
1	600	Whse.	CC-216	600	300/900
1	500	G.E.	MCF	230	300/900
2	450	Whse.		550	415
1	200	Whse.	CB-511.3	250	400/800

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G. E.	MT-498	2300	360
1	1500	ABB		2300	720
3	1000	A. C.	Mill	2300	240
1	1000	G. E.	MT-452	2200	321
1	500	G. E.	M-574Y	6900	900
1	500	Whse.	CW	550	900
1	400	Whse.	CW-900A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2300	435
1	350	G. E.	MT-442 Y	2200/4000	253
1	350	G. E.	IM-17A	440/2200	720
1	250	G. E.	MT-424-Y	4000	257
1	250	G. E.	MT-5598	2200	1800
1	250	Al. Ch.		550	600
1	200	G. E.	MTP-550	440	1170

SQUIRREL CAGE

2	650	G. E.	FT-559BY	440	3570
2	450	Whse	CS-1429	2300/4150	354
1	300	Whse.	CH	440	1170
1	200	G. E.	IK-17	440	580
8	200	G. E.	KT-557	440	1800
1	150	Whse.	CS-8568	440	880
1	150	Whse.	CS	440	580
1	150/75	G. E.	IK	440	900/450
2	125	Al. Ch.	ARW	2200	1750

SYNCHRONOUS

1	4350	C. W.	3501-SL	13800/6900	514
2	2100	G. E.	ATI	2300	360
2	1750	G. E.	ATI	2300	3600
2	2000	Whse.		2300	120
2	735	G. E.	ATI	2200/12000	600
1	750	G. E.	TS	2300/4600	720
1	500	Ideal	SM	2300/4160	1800
1	500	Whse.		440	900
1	450	Whse.		2300	1125
1	450	Whse.		2300	450
1	400	G. E.	TS	2200	400

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2300/2400	G. E.	450	250/300	2200/4600
2	2000	G. E.	450	600	2300/4600
1	2000	G. E.	500 25cy	650	11000
2	2500	G. E.	514	600	6600/13200
1	1500	G. E.	720	600	6600/13200
1	1500	C. W.	514	30/115	4600/13600
9	1000	G. E.	720	600	2300/4600
1	1000	G. E.	900	260	4600
1	750	C. W.	514	30/115	2300
1	600	G. E.	720	250	440/2300
1	500	Whse.	1200	115/230	2300

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	5000	Whse.	OISC	3	3300x2640
1	3500	Whse.	OISC	3	26400/13200x46
3	2000	G. E.	HVDDJ	1	66000/13800
3	667	G. E.	HD	1	13800x2300
3	1000	G. E.	HVDDJ	1	2400x480
6	1000	Wagner	OISC	1	13200x46

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	12500	Whse.	60/25	13200/13200
1	3000	G. E.	60/25	2300/2300/4000
2	2500	G. E.	25/62.5	2300/2300
1	1000	G. E.	25/58.3	4400/2300
1	500	Al. Ch.	2560	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G. E.	Condensing 425—750 P. T. T. Surface Condenser 3/60/2300/4000 V Direct conn exciter
1	1500	Whse.	Auto-extraction 190 lbs.—600° P.T.T. 60 lb. extraction 3/60/240 V. Dir. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200# 1 S.P. 5/20# G. Ext. Surface Condenser—3/60/2300.
1	1800	G. E.	Non-condensing 175/200 lbs. 1 S.P. 5/20 lbs. G.B.P., 440/3/60.
1	750	G. E.	Condensing 265# I.S.P. 440V. 3 ph. 60 cy.—New—1944.
1	750	Whse.	—Non-condensing 1 5# I.S.P. 40# B.P. 750 Kw. 280 V. D.C.

BELYEA COMPANY, INC.
43 Howell St., Jersey City 6, N. J.

CHECK WITH WAGNER FIRST

"Certified Rebuilt" Motors and Generators

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Allis Ch. b.b.	EW	250	1000
200	Allis Ch. b.b.	EW	250	650
175	Whse.	SK	230	900
150	Whse.	SK-201	230	300/900
100	Reliance	651T	550	1000/1600
75	F. Morse b.b.	DH-140	115	1600
75	Whse.	SK176	230	635
50	G.E. dynam. (4)	TLC25	250	1800/3500
50	Reliance b.b.	651T	230	750
50	Cr. Wh. b.b.	FH	230	1750
50	Whse.	SK185	230	300/900
40	Whse.	SK140	230	775
40	Gen. Elec.	RC32	550	1200
30	Imperial b.b.	D69	230	400/1600
20	Star b.b. (3)	SB	230	1750
25	Star b.b.	SB	230	1750
25	L. A. TEFC	RNA	230	850
25	Whse.	SK156	230	300/1200
25	Whse.	SK106L	230	1150

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
500	Whse.*	2300 AC	250 DC
300	Allis Ch.	2200/440 AC	125/250 DC
250	Allis Ch.	2200/440 AC	250 DC
200	Cr. Wheeler*	2300/4150 AC	250 DC
200	Whse.*	220/440 AC	85 DC
200	Gen. Elec.*	220/440 AC	125 DC
150	Whse.	2300/440 AC	275 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
105	Century b.b.	220/440 AC	70 DC
100	G.E.*	2200/440 AC	125 DC
100	Allis Ch.	220/440 AC	250 DC
75	F. Morse b.b.	220/440 AC	125/250 DC
75	Cent. b.b.	220/440 AC	125 DC
60	Gen. Elec.*	220/440 AC	60 DC
60	Whse (2)	220/440 AC	300 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Cr. Wh. b.b.	220/440 AC	240 DC
40	Gen. Elec.	220/440 AC	600 DC
30	Gen. Elec. (2)	220/440 AC	125 DC
30	F. Morse b.b.	220/440 AC	24 DC
25	Whse.	220/440 AC	125 DC

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Al. Ch.	MECW	125/250	1200
250	Allis Ch. b.b.	KW	250	1200
175	Allis Ch. b.b.	EW	250	900
150	Gen. Elec. b.b.	CDM	250	1500
105	Century b.b.	1500 amp.	70	1200
100	Allis Ch.	E	125	1200
100	Reliance	651T	600	1200
75	Cent. b.b.	D100X	125	1150
75	F.M. b.b.	DH	125	1800
75	G.E. b.b. (2)	CDM125	125	750
75	Whse.	SK	250	900
60	Whse. b.b. (2)	SK121	300	1200
50	Cr. Wh. b.b.	CYD	250	1800
50	Whse.	SK150	250	1100
40	Whse.	SK140	250	1100
40	Gen. Elec.	RC32	600	1750
25	Whse.	SK93	125	1750
25	C.W. b.b. (2)	CCD	250	1200

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
750	G.E.	Synch.	2200	514
700	Allis Ch.	Sq. Cage	440	900
500	G.E.	Sq. Cage	4000	1500
500	G.E.	Slipring	2300/440	450
500	G.E.	Synch.	440	900
450	Allis Ch.	Synch.	480	400
400	Whse.	Sq. Cage	2200	514
400	G.E.	Synch.	440	450
350	Whse. (2)	Slipring	2300	450
300	G.E. (2)	Slipring	2300/440	720
300	El. Machy	Synch.	220/440	360
300	Al. Ch.	Sq. Cage	2300/440	720
300	Whse.	Synch.	2300/440	600
300	G.E.	Slipring	440	360
250	F. Morse b.b.	Slipring	440	600
250	G.E.	Synch.	220/440	720
250	Whse. (2)	Sq. Cage	2300/440	1200
250	L.A. (2)	Sq. Cage	2300	1800
225	G.E.	Synch.	220/440	900
200	Gen. Elec.	Sq. Cage	220/440	1200
200	F. Morse b.b.	Slipring	220/440	600
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	2300/440	720
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2300/440	900
200	E. M.	Synch.	220/440	1200
200	E. M.	Synch.	220/440	514
175	G.E. (2)	Synch.	220/440	720
175	Whse.	Synch.	220/440	360
150	Whse.	Sq. Cage	220/440	900
150	G.E.	Synch.	220/440	450
150	Allis Ch.	Slipring	2300/440	720
150	G.E. (2)	Sq. Cage	2300/440	720
150	Allis Ch.	Sq. Cage	2300/440	1200
150	Rel. b.b.	Sq. Cage	220/440	1800
150	Allis Ch.	Sq. Cage	440	450
150	G.E. vertical	Slipring	4000/2300	1200
125	G.E. TEFC	Sq. Cage	220/440	3600
125	Whse.	Sq. Cage	220/440	900
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G.E.	Slipring	220/440	450
125	E. M.	Synch.	220/440	1800
125	Allis Ch.	Slipring	220/440	900
100	G.E.	Slipring	220/440	514
100	Burke b.b.	Synch.	220/440	1800
100	G.E.	Slipring	220/440	900

A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse. syn cond		4000/2300	900
625	Gen. Elec.	ATB	2300	450
600	Gen. Elec.	ATB	480	900
485	Allis Ch.	1 brg.	480	900
440	Gen. Elec.	TRH	240/480	450
312	Gen. Elec.	ATB	240/480	600
275	G. E. 25 cycle	ATI	480	750
235	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
156	Gen. Elec.	ATB	2300	900
150	Whse.		2300/480	900
125	Gen. Elec. (2)	ATB	240/480	900
75	El. Machy.		2300	900
56	G. E.	ATB	240/480	1200

• These are only partial listings of our large stock — send us your inquiries for prompt attention and complete quotations. Quick shipment—fair prices—fully guaranteed.

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4—B & W—Sectional, straight tube 400# pressure
1—150,000 #—600 # pressure
Other boilers, all sizes and pressures
1—1500 K.W.—13 stage, condensing turbine with 40 lbs automatic extraction driving 1500 KW—Generator—3 phase, 60 cycle, 2400 volts .8 P.F.—complete with all auxiliaries.
1—4000 K.W.—575 lb—125 lb automatic extraction Turbo—Generator Set.
Diesel Engines and Sets to 1000 KW.

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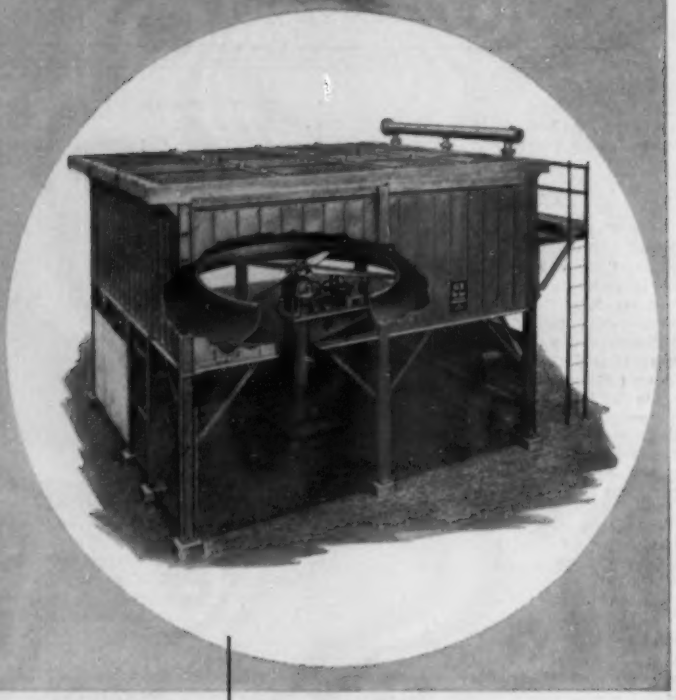
G-R fin-fan

more *than ever your best buy in*

AIR-COOLED HEAT EXCHANGERS



more *Applications*

The **fin-fan** exchanger is readily adaptable to practically every condensing and cooling application, particularly when the use of cooling water involves problems of supply, cost, scale or corrosion. Such flexibility is just one of many features, which make the G-R **fin-fan** your best investment in air-cooled apparatus.

more *Advantages*

Many important design and construction advantages are incorporated in the **fin-fan.** These include 100% effective cooling surfaces; maximum heat transfer afforded by exclusive G-R K-Fin Cooling Sections; fully prefabricated structure; predrilled supports, providing for addition of future units; *plus* bell-type fan ring for maximum efficiency with minimum horsepower required for fan.

more *Installations*

More square feet of K-Fin tubing, which forms the heat transfer surface, are being used in more types of air-cooled installations than any other design. Reason? Dependable ratings, design and workmanship backed by over 85 years of specialized experience in building quality heat transfer apparatus for varied services all over the world.

more

Dependable because completely G-R

The new G-R **fin-fan,** *completely G-R,* can be depended upon for structural strength, peak operating efficiency, ease of installation, operation and maintenance. It is a complete self-sustained unit combining the best transfer service available with tested and proved air circulation equipment. As a result of exhaustive tests conducted on the complete equipment over a six month period G-R can offer you *guaranteed performance* based on actual test data. This is just one more important reason why the new G-R **fin-fan** is your best buy in air-cooled heat exchangers.

GR331

G-R HEAT TRANSFER APPARATUS

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

fin-fan Air-Cooled Heat Exchanger

For easier and better pipe hanging!

This adjustable swivel hanger attached to a concrete insert is easy to install and will safely carry a wide range of loads. Like all Grinnell Hangers, it permits easy adjustment at any time after pipe is installed . . . to prevent sagging pipe and water traps, and to assure positive drainage. This is just *one* of the ways Grinnell Engineered Pipe Hangers save you maintenance expense, give you a better installation.

A good piping job is too important to jeopardize with improvised or inadequate pipe hangers and supports. There's a Grinnell Hanger for every piping requirement. All Grinnell Hangers comply with piping code specifications.

CB-UNIVERSAL CONCRETE INSERT (Fig. 282) . . . Used for pipe lines up to 12 inches where sizes of hanger rods cannot be readily determined in advance of ceiling construction. This insert is cast in one body size only. V-type teeth grip a special removable nut which is ordered separately and can be furnished tapped for ⅜", ½", ⅝", ¾" or ⅞" hanger rods. Face of insert can be concealed by ceiling finish.

ADJUSTABLE SWIVEL PIPE RING (Fig. 101) . . . Solid ring of malleable iron. Twelve sizes provide load range of 80 lbs. for ¾" size, to 1510 lbs. for 8" size.

LOCKING SWIVEL SHANK of Fig. 101 Pipe Ring . . . To obtain proper adjustment, swivel shank can be turned easily by hand when the weight of the pipe is temporarily taken off the ring. When weight is returned, swivel shank locks automatically, preventing change of adjustment due to vibration. Wire retaining ring keeps swivel shank and pipe ring or yoke from separating, makes assembly a single unit.

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPLIERS

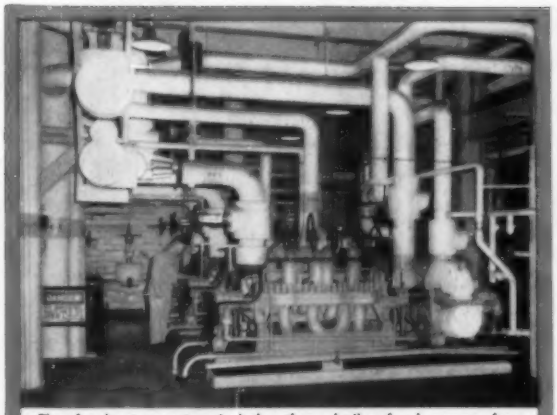
Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

Manufacturer of: pipe fittings • welding fittings • forged steel flanges • steel nipples • engineered pipe hangers and supports Thermolier unit heaters • Grinnell-Saunders diaphragm valves • prefabricated piping • Grinnell automatic fire protection systems

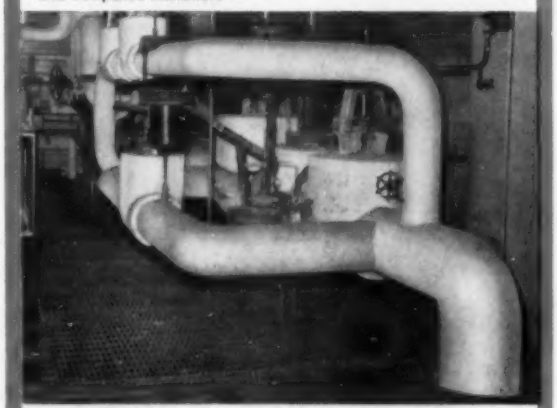
Carey super-light 85% Magnesia and Tempchek help "wrap up" new 20,000 KW Jamestown Plant

Efficiency in every single operation is a must at this plant in order to meet steadily increasing power loads. That's why Carey Super-Light 85% Magnesia and Carey Tempchek were the No. 1 choice for insulating plant boilers and piping throughout the entire new 20,000 KW installation. Fuel economy, maximum thermal efficiency are assured with these time-tested Carey products. They excel in efficiency, strength, workability and light weight . . . stand up under all kinds of humidity, vibration and water conditions . . . save space!

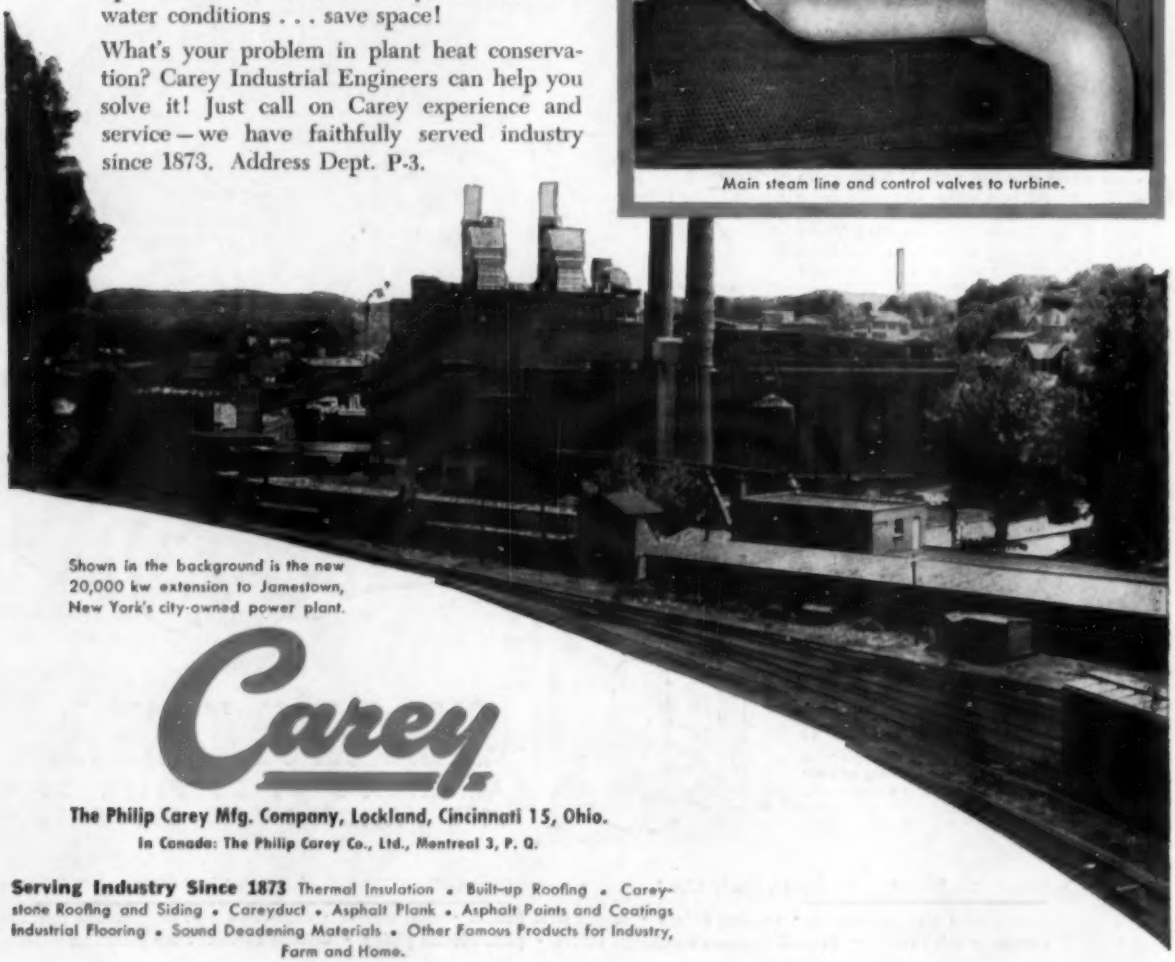
What's your problem in plant heat conservation? Carey Industrial Engineers can help you solve it! Just call on Carey experience and service—we have faithfully served industry since 1873. Address Dept. P-3.



The feedwater system includes three boiler feed pumps, four closed stage heaters, one de-aerating heater, and an evaporator. All piping is covered with Carey 85% Super-Light Magnesia and Tempchek insulation.



Main steam line and control valves to turbine.



Shown in the background is the new 20,000 kw extension to Jamestown, New York's city-owned power plant.

Carey

The Philip Carey Mfg. Company, Lockland, Cincinnati 15, Ohio.

In Canada: The Philip Carey Co., Ltd., Montreal 3, P. Q.

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